Biodegradation of Alpha-1 Fluid

SOLTEX

Environmental Impact of Materials:

The biodegradation rate of insulating oils is an important criterion to use when evaluating and choosing between them. This is particularly true when one considers that the most damaging argument against PCB-containing fluids was their persistence in the environment.

There are different means by which materials can degrade. Some ways require precise acidic or ultraviolet light conditions rarely found in nature. The yardstick by which to judge a material's environmental impact should be that of true biological degradation and evidence of use of the material by microorganisms in their food chain.

Biodegradation Rates:

The biodegradation rate of a material measures the speed at which microorganisms can break down the material. There are several ways in which biodegradation rate can be measured. One of the most widely accepted is Biological Oxygen Demand, or BOD.

This test measures oxygen use of microorganisms feeding on a sample of the test material. The higher the rate of oxygen use, the faster the metabolism of the sample. Some materials such as silicone fluid can be called degradable but are not biodegradable. These types of materials that are non-biodegradable will return a BOD value of zero. Samples are usually tested for 20 days, with oxygen use measurements taken every five days. The change in the rate of oxygen use shows that the microorganisms are adapting to use the sample more efficiently as a source of carbon in their diets.

Comparative Biodegradation Rates:

Table One shows the comparative rates of biodegradation for popular PCB substitute dielectric fluids, measured as Biological Oxygen Demand. This data shows that microorganisms adapted over the course of the test period to use the hydrocarbon fluids as nutrients. (1)

In another study, the Biological Oxygen Demand values for hydrocarbon based fluids and silicone fluid. This study measured the BOD for different concentrations of the samples, at five and twenty day intervals. The results are shown in Table Two.

This study shows that higher concentrations of the fluid samples slowed the utilization of the samples by microorganisms, as would be expected. The biodegradation rate of the FRH fluid in this study was very near that of conventional transformer oil. The inorganic silicone fluid showed very little degradation.

Soil Dissipation Studies:

A third study was undertaken to show the degradation of FRH fluid when it is spilled onto soil. A sample of FRH fluid was introduced to unpasteurized sandy loam soil, along with urea, a source of nitrogen. The soil was held at 24 ^{o}C. in a laboratory. Samples of the soil culture were taken each day and washed with a hexane and isopropanol solution to remove the remaining FRH fluid. The extracted solvent was tested for FRH fluid concentration by gas chromatography. The attached chromatograms show that the FRH fluid concentration in the soil culture decreased significantly, being almost completely degraded by day 11.

This study indicates that Alpha-1 Fluid will rapidly biodegrade in actual soil. Non- biodegradable fluids would have remained intact in the soil culture.

Other Research:

Degradation of materials in the environment can proceed by many routes. Degradation of silicone fluid requires an environment of ultraviolet light and acids in order to take place. (3) These materials can accumulate in the environment if these criteria are not met. Silicones have been shown to be accumulating in the environment by the U.S. Naval Research Laboratory in Washington D.C. (4) The accumulation of silicones in the environment may be very significant when we consider that wide spread use of silicones did not take place until the 1950's.

Conclusion:

These studies have shown that fluids such as Alpha-1 fluid are readily biodegradable. Microbiological organisms can use them as a source of carbon. When spilled onto soil they degrade quickly through the action of naturally found microbes in the soil.

Bibliography:

1. "The Biodegradability of Three Dielectric Fluids", a study performed by Ortech International Laboratories, Mississauga, Ontario, Canada, 1990.
2. "Low Fire and Environmental Hazards of Silicone Dielectric Liquids", a paper presented by S.L. Cassidy and J.H. Davis at the 6th BEAMA International Electrical Insulation Conference, Brighton, England
3. "Silicones in Chesapeake Bay Sediments", and "Silicones in Estuarine and Coastal Marine Sediments", Robert E. Pellenbarg, Environmental Chemistry Branch, Naval Research Laboratory, Washington, DC

Table One
Comparative Biodegradation Rates for PCB Replacement Fluids

Fluid	Days of Incubation	Biodegradation Rate
Fire Resistant Hydrocarbon	0	0
	3	0.03
	5	6.3
	10	17.2
	15	50.1
	20	122
Silicone Fluid	0	0
	3	0
	5	0
	10	0
	15	1.0
	20	3.6

Table Two
Comparative Biodegradation Rates for PCB Replacement Fluids

Fluid	Concentration Fluid, mg/l	Biological O_2 Demand
Fire Resistant Hydrocarbon	50	0.51
	100	0.65
	500	0.59
	1000	0.28
Conventional Transformer Oil	50	0.44
	100	0.58
	500	0.57
	1000	0.61
Silicone Fluid	50	0.01
	100	0.03
	500	0.09
	1000	0.08