

OXIDATIVE STABILITY, THERMAL STABILITY, AND VOLATILITY  
STUDIES OF ELECTRICAL CONTACT LUBRICANTS

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STUDIES OF ELECTRICAL CONTACT LUBRICANTS

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ABSTRACT

A series of fluids which represent a cross section of the market for electrical contact lubricants was selected for evaluation. The evaporation rate, oxidative stability, and volatility of the various lubricants as both catalytic and

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**Oxidative stability, thermal stability, and volatility studies of electrical contact lubricants**

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The evaporation rate, oxidative stability, and volatility of the various lubricants as both catalytic and... The following lubricant evaporation rate equation is presented.

$$\ln \frac{W}{W_0} = -k t = -A e^{-B/P} t$$

An oil-soluble copper salt was evaluated as an additive to poly-alpha-olefin and polyol ester fluids. The copper additive changes from being a catalyst of primary oxidation to an inhibitor of oxidation as its concentration in solution is increased. At the low concentration of 100 ppm, the copper additive catalyzes the primary oxidation and inhibits the secondary polymerization reactions. This low concentration of copper also preferentially oxidizes oxidation products in the presence of oils. At the high concentration of 3000 ppm, the copper additive is an effective oxidation inhibitor and inhibits both the primary oxidation and secondary polymerization reactions.

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## ABSTRACT

A series of fluids which represents a cross section of the variety of synthetic materials available on the market was selected for evaluation as electrical contact lubricants. The evaporation rate, oxidative stability, and thermal stability of the various lubricants on both catalytic and noncatalytic surfaces were studied by use of the Penn State microoxidation test which simulates thin-film boundary lubrication conditions.

The evaporation rate appears to be a complex function of the cup wall height, the molecular weight of the lubricant, the surface area, and the vapor pressure of the lubricant. The following lubricant evaporation rate equation is proposed.

$$\frac{dM}{dt} = 1639 h^{-.11} MW^{-4.8} A P^V$$

An oil-soluble copper salt was evaluated as an additive to poly-alpha-olefin and polyol ester fluids. The copper additive changes from being a catalyst of primary oxidation to an inhibitor of oxidation as its concentration in solution is increased. At the low concentration of 200 ppm, the copper additive catalyzes the primary oxidation and inhibits the secondary polymerization reactions. This low concentration of copper also preferentially oxidizes oxidation inhibitors in the presence of oils. At the high concentration of 2000 ppm, the copper additive is an effective oxidation inhibitor and inhibits both the primary oxidation and secondary polymerization reactions.

The behavior of perfluoropolyether fluids above and below the thermal decomposition temperatures was investigated. The role of oxygen in the degradation of these fluids appears to be to convert certain metals to Lewis acids by oxidizing them. In the presence of  $\text{Fe}_2\text{O}_3$  and  $\text{Al}_2\text{O}_3$  powders, the degradation of perfluoropolyether fluids occurs in two steps. Induction periods of little lubricant degradation are followed by rapid degradation. The first step involves the slow catalytic degradation initiated by the metal oxide Lewis acid sites. This reaction releases reactive gaseous products which attack the metal oxide and convert it to metal fluoride. The second step involves the rapid catalytic degradation caused by the strong Lewis acid metal fluorides. The Lewis acids  $\text{FeF}_2$  and  $\text{FeF}_3$  were identified to be products of reaction between the perfluoropolyether fluids and low carbon steel surfaces.