

Oxidation Stability of Natural Esters

This section discusses oxidation of natural esters and how they compare to each other and mineral oil.

The transformer industry focused on oxidation stability of mineral oil because certain by-products of the oxidation process produce potentially degraded electrical, chemical, and thermal properties of the oil, namely sludge and short chain acids.

Natural esters are chemically different from mineral oils, and rather than produce sludge and short chain acids, they tend to polymerize, creating rather benign larger molecules. However, natural esters oxidize at a much greater rate than mineral oils, and are not recommended for use in free breathing designed transformers and other equipment. While different types of natural esters have different rates of oxidation, there are important tradeoffs.

Within this section, the following documents are found:

- **CPS Reference Document:** Oxidation Stability of Envirotemp FR3 Natural Ester Fluid. This document is a summary of the issue of oxidation stability and summary of initial CPS tests.
- **CPS Certified Report:** Cooper Power Systems Oxidation stability of Envirotemp FR3 fluid as Measured by Power Factor Valued Oxidation. This report presents the comparative data based on the Doble Engineering PFVO Method of oxidation stability.
Conclusion: The increase in the PFVO value of FR3 fluid is within the Doble Engineering acceptable limit established for mineral oil through out the 140-hour test. A high-oleic acid fluid produced by another natural ester manufacturer failed to remain within the PFVO limit after 80 hours.
- CPS Report: Thin-film Surfaces of Envirotemp FR3 fluid Exposed to Air.
- CPS Certified Report: Field Analysis Of Envirotemp FR3 Fluid in Sealed versus Free Breathing Transformers
Conclusion: Changes of viscosity of FR3 fluid due to long term exposure to air through free breathing transformers occur very slowly. Increase in dissipation factor due to continuous air exposure will be measurable months to years before a change in viscosity is readily detectable. In contrast, thin films of natural esters can polymerize relatively quickly, so exposure to heated air should be minimized. Unlike mineral oil, there is no reduction in dielectric strength performance of partially to fully polymerized natural esters.
- CPS Technical Report: Coking Tendency of Dielectric Fluids at Contact Surfaces.
Conclusion: Mineral Oil produces quantum higher levels of coking than FR3 fluid on immersed copper surfaces.