

100% Envirotemp™ FR3™ Natural Ester Fluid

Soy-based dielectric fluid aids in extending free-breathing load tap changers' switch life, reducing maintenance requirements for Leesburg, Florida

Like many U.S. cities, Leesburg, Florida, known as the Lakefront City, had been relying solely on mineral oil-filled transformers for its power delivery needs. Nearly five years ago, Leesburg made the decision to incorporate soy-based dielectric transformer fluid as a way to improve its levels of safety and sustainability.

Since that time, the City has witnessed a range of benefits not only related to safety and sustainable supply, but also in reduced maintenance, extended equipment longevity, and a more favorable environmental footprint.

A Changing Industry

Many in the industry remain unaware of the fact that mineral oil is not the only available option when it comes to transformer dielectric coolants. In fact, there's a remarkable field-proven asset protection product that helps achieve higher levels of public and workforce safety, performance, and reliability, while keeping costs and liability down.

"Since the industry is changing so often, we had no previous experience with soy-based dielectric fluids," said Dave Thomas and Kenneth Bowling, substation technicians, Leesburg, Fla. "When Cargill* approached us, we felt this was the perfect opportunity to see if Envirotemp™ FR3™ fluid would be a good fit for Leesburg."

As a natural ester based fluid formulated from a renewable natural resource—seeds—Cargill's FR3 fluid is the best dielectric fluid to meet the strict quality requirements for optimum transformer cooling characteristics. The base oil of FR3 fluid is derived from renewable seeds, and is blended with performance enhancing additives to produce a fluid that has exceptional fire-resistant properties and favorable environmental attributes.

The typical application of seed oil-based fluids has been in sealed transformers, which limits both the amount of moisture and oxygen ingress. However, Leesburg took an unconventional approach to gaining experience with FR3 fluid by applying it to free-breathing load tap changers (LTCs).

Envirotemp FR3 Refilling Process

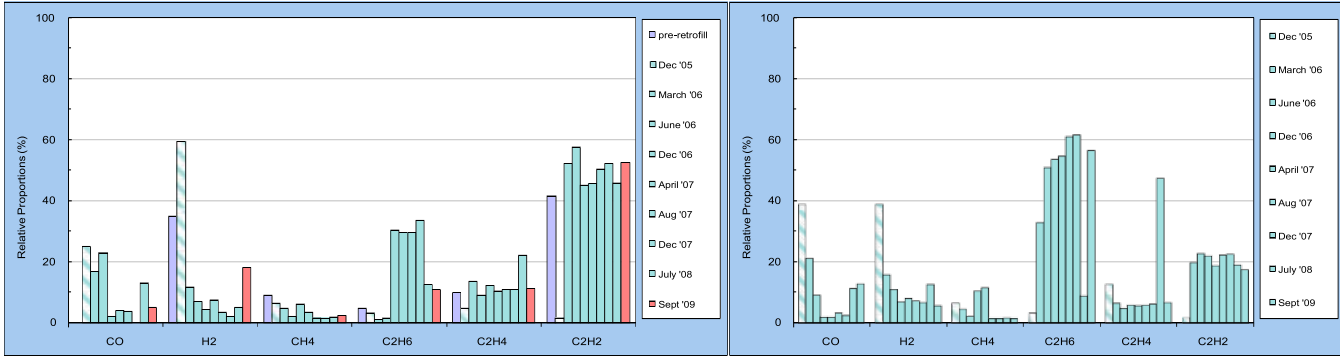
According to Dave Thomas, "Cargill was very helpful in starting the process of refilling the LTCs. They set up delivery of the FR3 fluid and provided guidance on the filling process." Two free-breathing LTCs were retro-filled under the guidance of Cargill. One unit held 700 gallons and the other held 360 gallons of FR3 fluid. One unit was converted to a nitrogen blanket system, while the other was maintained as a free-breathing LTC.

Post Refilling Experiences

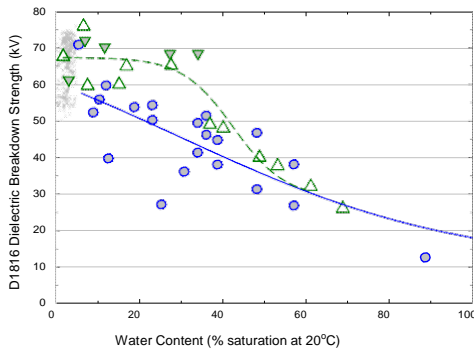
Following the initial filling process, Cargill scheduled and drew fluid samples for the Dissolved Gas and Analysis tests (DGA) every six months. A total of eleven DGA tests were performed within a five year period.

*Cargill acquired the FR3 dielectric fluid business from Cooper Industries in 2012.

During the trial period, the DGA as expected showed increasing levels of dissolved gases from the normal operation of the contacts frequently switching under oil. The concentration of gases was consistent with historical mineral oil DGA, except for the elevated level of ethane, the typical stray gas from FR3™ fluid.



The relative moisture saturation of the oil was also consistent with expectations; it tended to mirror the environmental conditions (as is the case with mineral oil). At the end of the trial period, the FR3 fluid in one of the LTCs contained 744ppm moisture, equal to 69.5% relative saturation. FR3 fluid’s dielectric strength, however, degrades less quickly than traditional mineral oil in the presence of moisture.



After three years (Leesburg’s normal preventive maintenance schedule for LTCs), and over 15,000 switch operations, both units were taken off line and inspection and preventive maintenance was performed. It was noted that carbon build up on the LTC contacts was minimal, and that contact degradation was less with FR3 fluid than the City’s experience with mineral oil.



As the trial period ended, the Leesburg Utility arrived at several conclusions. First, the performance of FR3™ fluid as a dielectric coolant was similar to that of mineral oil. The trial validated that DGA is applicable for FR3 fluid, and that there was no decrease in the time intervals between required scheduled outages. Second, there were two notable differences between LTCs filled with FR3 fluid compared to mineral oil—that of oil quality and LTC contact life. In the FR3 fluid-filled LTCs, Leesburg noted the absence of carbon particles in the oil, and that the contacts and switching mechanisms required much less maintenance than would have been required had they been filled with mineral oil. For Leesburg, the results of their trial provide an opportunity to extend maintenance cycles for switches under oil (load tap changer), a significant savings over the expected life of the device.

Reduced Environmental Impact

While taking some of the DGA samples, small amounts of fluid were spilled on the surrounding substation slag. The customer visited the site within one month of the sample and was surprised that the fluid spill was gone. When exposed to the outside environment, FR3 fluid's natural properties allow it to biodegrade rapidly. "Right now, FR3 would be significantly easier to clean up than mineral oil and would be a lot less expensive for the City in the event of a spill," continued Thomas.

Because FR3 fluid is derived from 100% soy seed oil, its environmental and health profile is unmatched by other dielectric coolants. Its biodegradation rate and completeness meet the U.S. Environmental Protection Agency (EPA) criteria for "Ultimate Biodegradability" classification. Standard acute aquatic toxicity and oral LD50 tests have proven the non-toxic qualities of Envirotemp FR3 fluid.

The environmental claims have been checked by the U.S. EPA. As a result, Envirotemp FR3 fluid received the first published EPA Environmental Technology Verification of transformer materials. Additionally, there are no current Florida Department of Environmental Protection reporting requirements applicable to spills of FR3 fluid.

Retrofitting Considerations

FR3 fluid remains a popular choice for upgrading fire safety and extending transformer life in retrofilled transformers. FR3 fluid offers a lower operating viscosity than silicone transformer oils and high molecular weight hydrocarbons at operating temperatures, so its cooling performance is superior. Because it is fully miscible with conventional transformer oil, it is ideal for refilling transformers. FR3 fluid increases the life expectancy of a transformer and reliability by reducing the insulation paper aging rate and essentially eliminating reported problems relative to mineral oil.

FR3 fluid extends insulation life by a factor of as much as five to eight times because it has the unique ability to draw out retained moisture and absorb water driven off by aging paper. It also helps prevent paper molecules from severing when exposed to heat. These properties can result in an increase of overloadability and longer transformer insulation life, leading to both reduced life cycle cost and delayed asset replacement.

For Leesburg, refilling transformers will be the next step—they've initiated a six year program to refill each of their eleven power transformers and their new LTCs with FR3 fluid.

More than 300,000 new and retrofilled transformers are in service today.

For more information, visit www.envirotempfluids.com or contact us at fr3fluid@cargill.com.