



The FR3 Fluid Experiment

Julius Heslop
Power System Engineer Senior



Agenda

- FR3, What is it?
- Pro's and con's of ester oil
- Austin Energy's history and experience with FR3 fluid
- Our choice and why

What is FR3?

- FR3 fluid by Envirottemp- is a fire resistant natural ester dielectric coolant derived from renewable vegetable oils
- Other commonly coolants include high molecular weight hydrocarbons (HMWH), dimethylsiloxane, synthetic esters (Envirottemp 200 fluid), and natural esters (Envirottemp FR3 fluid).



Safety Factors

- Ester dielectric coolants offers flash (330°C) and fire points (360°C) that are much higher than that of their mineral oil (160 & 180°C) counterpart, giving them a superior safety record.
- The byproducts of ester fluid combustion are water, carbon dioxide and carbon monoxide which are less toxic than the carbon, nitrogen verse sulfur oxides produced by a mineral oil fire





FR3 Oil benefit

FR3 installations

- Article 450-23 of the NEC permits less-flammable liquid-insulated (FR3) transformers up to 35kV to be installed indoors, without a vault and without an automatic fire extinguishing system, if located in noncombustible occupancy areas of noncombustible buildings provided.

Mineral oil installations

- Electrical equipment installed outdoors that are containing mineral oil should be separated from other equipment, buildings, and the adjacent property line to minimize the impact of a major fire (IEEE 979)



FR3 Oil Benefits

Transformer Life cycle

- An conservative estimate is anticipates that new transformers would experience a life extension of 33% over mineral oil
- FR3 fluid is proven to protect the insulation paper 5-8 times longer than mineral oil.



LIFE EXTENSION
significantly beyond what is
possible with mineral oil



FR3 Oil Benefits

Transformer performance

- FR3 is capable of 20-30% higher overloads with the same equipment compared to mineral oil without sacrificing insulation life.
- Reduces transformers no load losses



INCREASE LOAD

additional load capacity within the existing transformer footprint



OVERLOAD CAPACITY

gain increased safe overload



FR3 Oil Weighted Benefits

Economic analysis

- Lowered total cost of ownership
- Initial investment of new transformer an mineral oil filled vs. Envirotemp®, FR3 filled is approximately 33% more
- Also, consider cost changing installation requirements and construction standards.



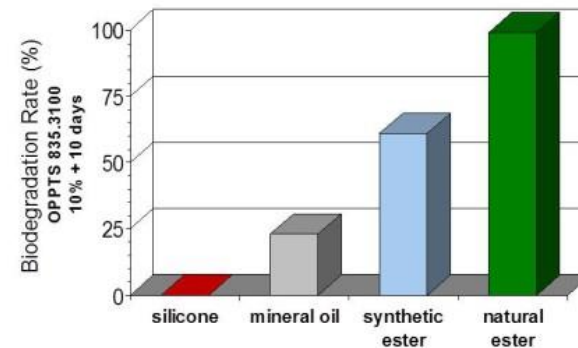


FR3 Oil Weighted Benefits

Biodegradable Fluid

- FR3 is a biodegradable fluid and has low seepage
- When FR3 fluid exposed to air will form a thin film called polymerization.
- FR3 fluid contamination can be difficult to clean, compared to mineral oil.

Biodegradation Rate of Dielectric Fluids
EPA OPPTS 835.3100





AE Experience

- Austin Energy has used this ester fluid (FR3) for 10 years
- Austin Energy's FR3 usage was only on distribution transformers
- The conversion to FR3 was based purely on innovation and environmental purposes



GreenChoice®



AE Experience Functionality & Reliability

- AE's transformers were larger in volume due more oil was required to cool the same kVA (clearance adjustment).
- AE's transformers were heavier in weight due more ester oil needed for each transformer (portability).
- Few of the distribution transformer's paper didn't absorb the oil and the few transformers failed (stock).



AE Experience Cost

- Cost approx. \$8 more per gallon for oil
- Cost increased 15% on average for new transformer versus mineral oil for AE
- Cost more waste cleanup because the same work for FR3 as for mineral oil (plus storage).
- Cost saving on extended life assumes you are replacing transformer every 30 years



AE Experience Waste management

- **“Waste management for Mineral and FR3 oils are the same procedure.”** However, with mineral oil you have to dispose of it as “hazardous material”, while with FR3 you do not.
- When Polymerization occurs with the exposure to air in couple days. Removal of the polymerized fluid is labor intensive on concrete or metal.
- Landfills have asked us to create separate waste profiles for soils containing FR3 oil. Since the FR3 is recyclable.

Conclusion



- Austin Energy's 10 years of experience, found it too costly including supplemental cost to stay with FR3 oil in the dist. transformers