

ESTER DIELECTRIC FLUID ENVIRONMENTAL FATE AND FIELD IDENTIFICATION



PROJECT HIGHLIGHTS

- Research diagnostic characteristics for identifying ester spills
- Testing of field screening methods
- Research analytical compounds for laboratory quantification
- Evaluate environmental degradation for soil, porewater, and concrete
- Evaluate individual compounds and identify potential toxicological risk to human health and the environment

Background, Objectives, and New Learnings

Electric utilities operate numerous transformers in the transmission and distribution of electrical energy. These transformers contain coolant dielectric fluids which may be unintentionally released due to equipment failure, maintenance accidents, fires, etc. Releases of mineral oil from equipment present potential environmental and economic burdens, whereas ester dielectric fluids may offer improved operating performance to improve grid reliability, reduce fire risk, and may have a reduced environmental impact based on a low potential for persistence, bioaccumulation, and toxicity.

The ester dielectric fluids may be natural or synthetic in origin, deriving from commodity seed oils or inorganic feedstocks. While the operating characteristics of esters in the electrical system have been studied extensively, the environmental fate and transport of these fluids has yet to be investigated.

The objective of this project is to document environmental fate and transport characteristics of natural and synthetic esters through visual, analytical, and potentially other diagnostic tools under conditions similar to those that would be present following a fluid spill from electrical equipment. The results of this research may support responders with a need to identify and efficiently respond to such spills.

Benefits

This research has the potential to facilitate energy system adoption of natural and/or synthetic ester dielectric fluids. These fluids appear to have less potential for environmental impact than the petroleum-derived mineral oils commonly used throughout the energy transmission and distribution system.

As the fluids are adopted by more companies, the results of this research may inform emergency spill response procedures by providing an evaluation of field and laboratory analytical techniques. Extending knowledge of degradation rates and products in soil, concrete, and porewater supports evaluation of deployment risk for ester dielectric fluids.

Additionally, the results of this project may benefit the public by having more equipment filled with alternative dielectric fluids that are potentially safer to the environment and the have lower persistence, bioaccumulation, and toxicity levels for humans and animals.

Project Approach and Summary

The project approach is designed to provide background literature reviews; bench testing of field identification methods; laboratory analytical testing; field testing of ester degradation in soil, water, and concrete; and a toxicological evaluation of dielectric fluid esters and their degradation products.

The following are the proposed tasks for this project:

1. Development of a conceptual site model for ester dielectric fluid spills to the environment.
2. Evaluation of the environmental behavior of ester fluids in soil and water.
3. Bench scale testing of field identification methods.
4. Bench scale testing of ester spill impacts on turf grasses.
5. Field testing of ester degradation when applied to soil, concrete, and water.
6. Identification of laboratory analytical methods to identify ester spills in soil and water.
7. Laboratory analytical work to identify compounds of interest for degradation and toxicological assessments.

Deliverables

Project deliverables may include update meetings, presentations of results, and written technical reports.

Price of Project

The cost of the project per funder is \$125,000. The research can begin immediately with one funder. The full scope of work requires 5 participants. Funding can be split over 2024, 2025, and 2026. The project qualifies for self-directed funding.

Project Status and Schedule

Research is scheduled to begin once an initial funder joins the project. The full scope is estimated to take approximately 16 months to complete.

Who Should Join

This research is relevant for any utility currently deploying, or evaluating the deployment, of natural and/or synthetic esters in transformers.

Contact Information

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