



Magazine Article



Western looks into bio-based transformer dielectric fluid

Western is exploring the use of bio-based dielectric fluid—like soy oil—instead of mineral oil to fill and insulate transformers.

"While Western has not yet installed a transformer with this fluid on our system, perhaps it's time to look into this option and assess if it makes good business sense to do so," said CSO Substation Electrical Engineer **Jeff Hein**. This summer, Hein and other Engineering, Environment, Maintenance and Procurement employees throughout Western performed market research of the benefits and costs of using bio-based fluid versus mineral oil.

Bio-based transformer dielectric fluids, or natural ester fluids, have been tested and retrofilled into many transformers during the last 10 years. In addition, some utilities have large 161-kV, 200 MVA transformers retrofilled with natural ester fluid. "We decided the preferred approach was to get some experience testing and monitoring the fluid on smaller transformers before we are required to use bio-based fluids on larger power transformers," Hein said.

"Bio-based fluids have a far superior resistance to fire than mineral oil," he continued. "This would help prevent future fire disasters, like the July 4, 2004, Arizona Public Service Westwing Substation fire incident where five large, single-phase, 500/230-kV power transformers burned."

There are many environmental benefits of using bio-based fluid, including rapid breakdown, or decay, in nature. If there's a spill, it's not as harmful to the surrounding area. But under EPA regulations, just like mineral oil, spills must still be cleaned up quickly. "Any oil spill can pollute the soil, as well as nearby above-ground and underground water sources," explained CSO Environmental Engineer **Dave Pearson**. "Once the soil is contaminated, it's not suitable for other uses, like growing crops or grazing livestock. That's why it's so important for us to contain and clean up spills very quickly.

"However once we've cleaned up the spill, a possible advantage to bio-based dielectric fluid is that the contaminated soil may be more readily accepted by landfills for disposal, since it will biodegrade in a landfill faster than mineral oil," he added.

Bio-based oil biodegrades faster than mineral oil and can use micro-organisms in the soil to break it down. "It's still a waste product, but it's not considered hazardous material," added RM Environmental Protection Specialist **Gene Iley**.

Even though the fluid is not considered hazardous, the Environmental Protection Agency still requires it to be contained—and cleaned up in the case of spills—like all other transformer oil spills.



Other benefits of using bio-based fluid include:

- The fluid is considered a renewable material.
- Reduced land size requirements for substations because transformers can be set closer together, leading to lower facility costs.
- Extra loading capacity and extended life of transformer. "That will lead to a cheaper life-cycle cost," said Hein. "Through this cost-containment effort, we can save our customers money by maintaining or reducing service rates."
- Testing and evaluating dissolved gases in bio-based fluids is comparable to mineral oil.

Another benefit is that it helps Western improve performance reviews under DOE's [Pollution Prevention, or P2, program](#).

"Besides, many of our customers in the Upper Great Plains grow the materials—like soy—used to create bio-based fluid," explained Hein. "We could be supporting our customers, while meeting [Presidential and DOE mandates](#) and improving our environmental stewardship."

With all of these benefits, there are still a few concerns. The fact that Western has never used, nor tested, bio-based fluid in any of its transformers means that those involved would be jumping in without experience. "Utilities, both private and public, and manufacturers have installed bio-based fluids in hundreds of transformers to date and operated them without incident," responded Hein. "We would be able to draw on the manufacturers and other utilities' experience and expertise when we get ready to install and test this bio-based fluid."

Another concern is that once a transformer has been retrofilled with bio-based fluid, the oil-handling equipment still requires a mineral oil flush through it to keep it in good working order. That mineral oil would still be considered hazardous waste in California and would have to be handled accordingly.

"So far, the industry has not encountered significant problems with the fluid, except for some leaks around gaskets due to using the different oil, but that's easily corrected by tightening gasket bolts," added Hein.

There's also the concern about how much it costs to refill a transformer. "Depending on the size of the transformer, it can take from thousands of gallons of oil to tens of thousands of gallons of oil to fill it," explained Hein. "It [bio-based fluid] will cost 20 to 30 percent more than mineral oil for just the bio-based oil. When buying a new bio-based oil filled transformer, the initial cost is only about a 5- to 8-percent increase more than a standard mineral oil-filled transformer.

"We should look at testing the process of refilling and maintaining transformers at a manned-station to mitigate problems so that we can be ready to deal with new bio-based units when we get them," continued Hein. "Rocky Mountain and Upper Great Plains regions will provide test units for trying out the biodegradable oil."



Meeting industry mandates

Purchasing new transformers that use bio-based fluid and retrofilling old transformers with the environment-friendly oil fits in with the U.S. Department of Agriculture's [Farm Security and Rural Investment Act of 2002 \(pdf\)](#).

"It's anticipated within the next several years use of bio-based fluid material could be mandated," explained CSO Substation Electrical Engineer **Jeff Hein**. "Perhaps by discussing the use of this material now and reaching a decision on how to test performance and potential implementation, we can get ahead of the curve and proactively address this subject."

Also, the Department of Energy's [Pollution Prevention Program](#), or P2—which promotes using environment-friendly products—is founded in the "Greening the Environment through Waste Prevention" Executive Order 13101, and "Greening the Environment through Leadership," EO 13148.

Agencies submit progress reports to DOE on how they are achieving the program goals. Using bio-based fluids in transformers is one way Western could help meet those goals. "Again, bio-based fluid would need to meet Western's technical and operational requirements before systemwide use," Hein said.