

Retrofilling Mineral Oil Transformers With Alpha-1 Fluid

*Dr. David Sundin
Technical Dept.
DSI Ventures, Inc.*

The fire safety margin of existing transformers and switchgear can be dramatically improved by changing the insulating oil to a fire resistant one. Power service and electrical repair companies have discovered this to be a valuable service to offer their customers. This paper discusses the reasons why transformer owners are retrofilling their units and gives guidelines to observe when performing this procedure.

Why Are Transformers Being Retrofilled?

Transformer owners are choosing to retrofill their units for a variety of reasons. All of them are based on the need to increase the fire safety of the transformer. Building owners and utilities are being advised by insurance companies to protect their buildings and contents. Electric utilities want to reduce their potential liability of explosion or fire.

Some of the most common reasons are:

Expanding a building: When a building is expanded or remodeled, an outdoor transformer that was a safe distance from exterior walls may now be too close to use conventional transformer oil.

Changing insurance regulations or fire codes: As building codes and insurance regulations change, transformers may be reclassified or be required to meet more stringent fire protection guidelines.

Liability exposure: Transformers located near public roads or walkways may present an exposure to a potential liability that the owner would like to reduce.

Existing PCB installations: In many cases, users have transformers that have high concentrations of PCB containing fluids that must be replaced.

Often, a transformer owner will need to construct a barrier or enclosure around a transformer. Changing the insulating fluid from transformer oil to a fire resistant fluid is usually far less expensive and may be acceptable to the regulatory or insurance parties involved. Retrofilling the transformer with Alpha-1 fluid is an easy way to increase the fire safety margin of the unit, lowering the risk of fire or explosion.

Retrofill Fluids:

The fire resistant oils discussed here are defined by the U.S. National Electrical Code as "Less Flammable Fluids". Part of this definition is that they have a fire point of at least 300°C. (ASTM Method D92). This is significantly higher than the typical 160°C. fire point of conventional transformer oil. Alpha-1 Fluid meets these requirements, with a typical fire point of 306°C.

Alpha-1 Fluid is especially well suited for retrofilling transformers that were designed for conventional transformer oil. Alpha-1 is the only fluid made that is specifically engineered to be used in retrofill situations. Alpha-1 Fluid has been used in many retrofill applications worldwide without any reported cooling, material compatibility, or electrical problems.

Alpha-1 is based on synthetic hydrocarbon oils. Alpha-1 is compatible with conventional transformer oil and normal transformer construction materials. Alpha-1 fluid will mix easily with any residual transformer oil, chlorinated solvents, or PCB-containing fluids without any foaming or dielectric problems

Alpha-1 has a far lower viscosity than any other hydrocarbon based fire resistant oil. Because the transformer was designed to be cooled with another fluid, it will run warmer after retrofilling. Using Alpha-1 Fluid, with its low viscosity, will possibly minimize this problem.

DSI Ventures does not recommend the use of silicone-based fluids in oil retrofill jobs because of foaming or dielectric and foaming problems that may arise. We recommend that only hydrocarbon based oils be used for retrofilling transformers.

Transformer Cooling:

Transformers that were designed for use with other dielectric oils will run warmer when filled with a fire resistant oil. Alpha-1 Fluid's low viscosity will minimize the temperature rise associated with the retrofill. Typically, a transformer designed for conventional oil will run 2 - 5 °C. warmer after being retrofilled with Alpha-1 Fluid.

Residual Transformer Oil:

A successful retrofill job depends on removing as much of the original fill fluid as possible. A small amount of the original oil will remain in the unit, saturated in the porous paper and wood components. This residual oil will be replaced by the Alpha-1 Fluid over a period of time. The majority of it, however, will be replaced within six months after the unit is retrofilled.

Mixtures of transformer oil and Alpha-1 Fluid will have good electrical characteristics. If the dielectric oil being replaced is conventional transformer oil, the mixture will have a lower fire point than the Alpha-1 Fluid would by itself. Mixtures that contain more than three or four percent residual transformer oil may have a fire point that is below 300°C.

If a 300 °C. firepoint is required, a second full or partial retrofill should be considered when the equilibrium between the two fluids has been established (approximately six months)

Retrofill Procedure Guidelines:

The procedure to retrofill a transformer oil with a fire resistant oil is relatively simple and straightforward.

These are some of the key points to be used in retrofilling electrical equipment originally filled with another fluid. As each service job is unique, this list is to be used as a guideline; it is not intended to be a complete list of all procedures that may need to be done to complete this work. Other steps may be needed to comply with applicable regulations and good engineering practice.

Key Steps in Retrofilling:

1. Ground all equipment (transformer, pump, tanks, etc.) to control static discharges while you are working.
2. Make sure that the unit is de-energized, and access the unit in accordance with owner's directions.
3. Perform transformer insulation tests (at minimum, a "Megger" test @ 2,000 volts d.c.)
4. Discharge the transformer's high voltage windings and cables.
5. Reground the transformer windings.
6. Drain the existing oil.
7. Allow a minimum time of one half hour for transformer oil to drain out of the core and coil.
8. Using a small pump and hoses, manually flush the interior of the unit with warm retrofill fluid (5% of the unit's oil volume is recommended). The procedure will be easier if the retrofill fluid is warmed to at least 100°F (40°C.). Be sure to flush down the core and coil if possible. Try to wash as much of the original fluid as possible out of the unit. Discard this flush fluid in an appropriate manner and replace the manhole as soon as possible.
9. Allow the unit to drip for 30 minutes, then vacuum or pump the remaining fluid from the bottom of the tank.

10. Replace gaskets if needed (high firepoint hydrocarbon fluids are compatible with gaskets used with conventional transformer oil). DSI Ventures recommends Viton gaskets.
11. If the transformer is rated for full vacuum, apply a vacuum of on the unit.
12. Begin the retrofill, with warmed fluid, if possible.
13. Filter the retrofill fluid through 5 micron filters as it is being pumped into the unit.
14. Wait before performing the next insulation tests. This gives air bubbles an opportunity to rise to the top of the fluid. The wait time is dependent on the fluid's temperature. Four hours wait time at a fluid temperature of 50-80°C. is recommended.
15. Perform another set of insulation tests, as in step 3. If the test value has decreased, investigate to determine the cause.
16. Wait again before to energizing the unit. This gives the retrofill fluid time to saturate any porous materials that may have become dry during the process. The wait time is dependent on the temperature of the retrofill fluid. Twenty four hours wait time is recommended.
17. Observe the unit for leaks during this wait time.
18. Energize the unit without load.
19. Wait three hours minimum after energizing, before adding the load.
20. Apply the load.
21. On the following day, check the unit's temperature and pressure, observe it again for leaks and perform other standard observations and checks.
22. After the retrofill, follow standard maintenance intervals and procedures. Pay close attention to possible leaks from any old gaskets that were not replaced.

Conclusion:

Retrofilling its original fluid to a fire resistant fluid is a way for transformer owners to increase the fire safety of their equipment. Transformer service companies can solve problems for their customers by performing this procedure, thus providing a valuable service.

Alpha-1 Fluid is made especially for retrofilling transformers. Alpha-1 has been used in thousands of retrofill applications by service companies and utilities throughout the world. Alpha-1 Fluid is 100% hydrocarbon, so it will mix easily with any residual transformer oil in the unit. Transformers that were designed to use conventional transformer oil will run only slightly warmer with Alpha-1 Fluid.

When performing a retrofill, remove as much of the residual transformer oil as possible. Transformer oil that leaches from the paper and wood in the unit will mix with the retrofill fluid, possibly lowering the fire point. The fluid should be tested in six months to determine if additional work is needed.

For additional information or more copies of this paper, please contact:

DSI Ventures, Inc.
1320 E. Commerce Street
Tyler, TX 75702
Phone: 903-526-7577
FAX: 903-526-0021

Typical Properties of Alpha-1 Fluid

Property	Conventional Transformer Oil	Alpha-1 Fluid
Fire Point, °C. ASTM D92	160	306
Pour Point, °C.: ASTM D97	-40	-55
Viscosity, cSt. @ 100°C.:	3.0	8.4
Dielectric Strength: ASTM D877, kV	30	40
Power Factor, % @ 100°C., ASTM D924	0.01	0.01
Spec. Gravity ASTM D1298	0.86	0.84

Change in firepoint of Alpha-1 as a result of transformer oil contamination

