Analysis of Alpha-1 Fluid After 25 Years of Use:

Examination of Service Aged Alpha-1 and A Discussion of Aging and Applications

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Executive Summary:

Alpha-1 fluid is a fire resistant dielectric fluid made from synthetic hydrocarbon base oils.

Developed in 1992, Alpha-1 Fluid is used in a variety of applications that require electrical cooling and fire resistance.

This project collected a sample of Alpha-1 from the very first transformer filled with the fluid. The original fluid was still in use, after 25 years of operation.

Analysis of the aged Alpha-1 Fluid shows that there has been no change in the oil's properties. After a quarter-century of use, the physical, chemical and electrical characteristics are the same as when the oil was manufactured in 1992.

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Alpha-1 Fluid:

Alpha-1 Fluid is a fire resistant electrical insulating oil made from synthetic hydrocarbons.

It was originally developed to be a safer alternative to standard transformer oil in power and distribution transformers. Because of its excellent heat transfer characteristics and material compatibility, Alpha-1 Fluid has been used in variety of specialty applications, from cooling electronics to radio transmission devices. Alpha-1 is so efficient in removing heat that manufacturers can reduce the size and weight of their products. (1,2)

The First Application

One customer of the first production batch of Alpha-1 Fluid was Kuhlman Electric Company, which installed the oil in a 2500 kVA padmount transformer. The transformer operated without incident, through increasing loading profiles and cycles and the temperature variations common in Kentucky.

In 2016, this Alpha-1 Fluid was sampled and tested so that it could be compared with the characteristics of the same batch of new Alpha-1 Fluid. This comparison allows us to see the rate and extent of aging.

Samples of Alpha-1 Fluid were sent to TJH2B Laboratory and Doble Engineering Laboratory for analysis per standard ASTM tests. The results are shown in Table One, along with DSI's Quality Control data from the same batch. (3, 4, 5)

Test Results:

Oil Characteristic:	New Alpha-1 Fluid (batch 9201)		Service Aged Alpha-1 After 25 Years
Acid Number, D974	0.01	▭	0.027
Dielectric Strength D877	40	▭	37
Dielectric Strength D1816	31	▭	27
Power Factor 40 C. D924	0.01	▭	0.02
Power Factor 100 C. D924	0.10	▭	0.26
Color D1500	L0.5	▭	L0.5
Flash Point, D92, C	268	▭	270
Fire Point, D92, C.	304	▭	304

The results of the laboratory tests show that there has been very little deterioration of the characteristics of Alpha-1 Fluid. All test results were well within IEEE Recommendations for continued use of service-aged fluids.

In this picture, the sample on the left is new Alpha-1 Fluid, while the sample on the right is Alpha-1 that has been in service for a quarter century: The service-aged fluid has not discolored, even after 25 years' use. Its characteristics are virtually identical to that of the fluid when it was new.

The Significance of Test Results

Low Acid Value: Acids are formed as an oil ages and oxidizes. The sample of 25 year old Alpha-1 showed that the acid value had risen from 0.01 to 0.027 mg KOH/g, a negligible amount. This indicates that very little oxidation has occurred in the oil sample. (6)

Low Power Factor: The power factor test is a sensitive way to measure how much the oil has aged. Even after 25 years, the power factor of the Alpha-1 sample shows that the oil has undergone little change and is suitable for continued use.

High Dielectric Strength: The dielectric strength, has changed very little. The 25 year old Alpha-1 Fluid meets all criteria for continued use.

Flash and Fire Points: The flash and fire point were not affected.

No Corrosive Sulfur As an Engineered Dielectric Fluid, there is no sulfur in Alpha-1.

No Polymerization: Unlike vegetable oils, Alpha-1 can be exposed to air and used for years at elevated temperatures, without worrying about the oil degrading, thickening, or becoming rancid.

Conclusions:
The results of the tests show that the characteristics of Alpha-1 Fluid that was service aged for 25 years years is in excellent condition, and differs very little from the characteristics of the same batch of Alpha-1 when it was new.

The sample of Alpha-1 Fluid easily exceeds the requirements for continued use of standard transformer oil (IEEE C57.104) and for Service Aged Fire Resistant Hydrocarbon Fluids (IEEE C57.12)

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Applications for Alpha-1 Fluid:

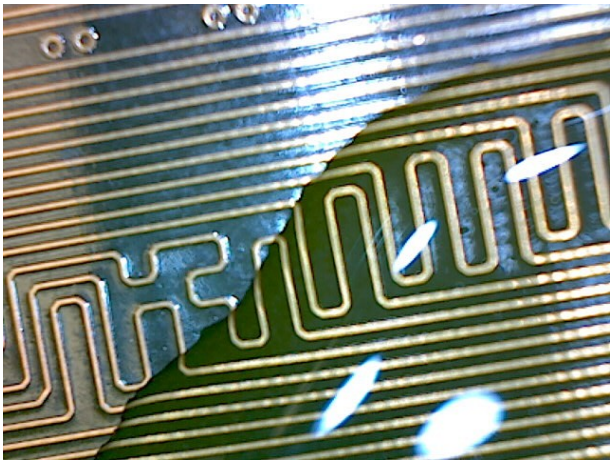
New Power Equipment: Alpha-1 Fluid is used for OEM fill in new distribution transformers and switchgear. Its clarity, compatibility and performance have made it the choice for OEMs and their customers.

Retrofilled Equipment – Equipment that was designed and originally filled with other fluids can benefit from changing to Alpha-1 Fluid. Alpha-1 Fluid adds a significant safety margin to equipment designed for use with standard, more flammable oils. Alpha-1 has been used to retrofill a variety of transformers, filled with a wide range of other fluids, including PCB, Wecosol, mineral oil and vegetable oils. Alpha-1 mixes well with these fluids, and ensures that there won't be a problem with separation or foaming.

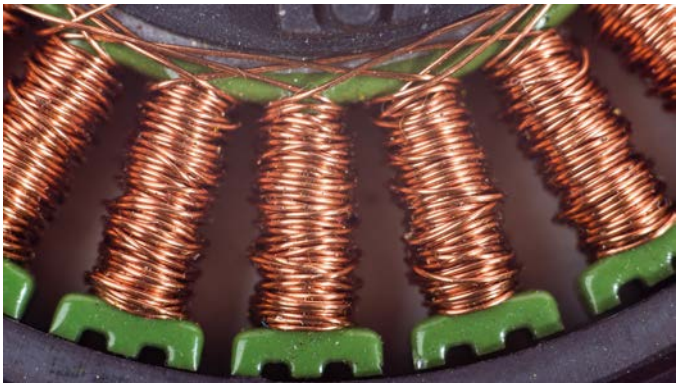
Retrofilling with Alpha-1 Fluid is usually a simple matter of draining, flushing and then refilling the transformer (5). Contact DSI for more information regarding retrofilling procedures with Alpha-1 Fluid.

Electronic Circuitry – Amplifier circuits and other power electronics can be safely cooled with Alpha-1 Fluid

Batteries – Batteries can be cooled with the highest degree of fire protection with Alpha-1 Fluid.



Electric Motors – Electric motors are cooled and insulated with Alpha-1 Fluid. Unlike other dielectric fluids, Alpha-1 has excellent lubricity, which extends the life of moving parts immersed in the fluid.



How Alpha-1 Adds Value:

- Alpha-1 Fluid is a fire-resistant dielectric fluid used in a variety of electrical applications.
- Alpha-1 is an Engineered Dielectric Fluid. It's made from synthetic oils, with food grade additives.
- Alpha-1 is Listed by FM Global for use in electrical transformers located indoors, per NEC Section 450-23
- Alpha-1 Fluid is non-toxic and non-hazardous. Alpha-1 Fluid is classified as “non-flammable” by the US Dept. of Transportation.
- Alpha-1 doesn't pose a risk to workers.
- Alpha-1 exceeds IEEE standards for electrical and fire safety.
- Alpha-1 Fluid is readily biodegradable to minimize risk to the environment.
- Alpha-1 Fluid has a very low carbon footprint and Global Warming Index (GWI)

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References:

1. Redacted.

2. Insulating Liquids: their Use, Manufacture, and Properties"; A.C.M. Wilson, IEE Press (London)
3. Contact DSI for more information on test laboratories or methods used.
4. "Low Fire and Environmental Hazards of Dielectric Liquids", a paper presented by S.L. Cassidy and J.H. Davis at the 6th BEAMA International Electrical Insulation Conference, Brighton, England
5. Emmanuel O. Aluyor and Mudiakeoghene Ori-jesu. African Journal of Biotechnology Vol. 8 (6), pp. 915-920, 20 March, 2009
6. DSI Sales records as of July, 2016
7. FM Global Listing for Alpha-1 Fluid. Contact DSI Ventures for more information.
8. ASTM Standard D3487, “Standard Specification of Electrical Insulating Oil of Mineral Origin”, ASTM International, Conohocken, PA
9. IEEE C57.104, Standard Guide for Acceptance and Maintenance of Transformer Oil of Petroleum Origin.
10. These values are typical for DSI Alpha-1 Fluids. Please contact DSI for specification values.
11. Please refer to “Guide for Retrofilling Transformers with Alpha-1 Fluid”. Available from DSI Ventures, Inc. sales@dsiventures.com or 903-526-7577 Note that other steps or procedures may be necessary, given the details of the retrofill application.
12. “Choosing the Right Heat Transfer Fluid for Electronics Cooling ” Avialable at www.dsiventures.com.

Other Useful Reference Material

- "Insulating Materials for Design and Engineering Practice", Vol 2; F.M. Clarke; 1959, Wiley & Sons
- ASTM Standard Specification D3487 “Standard Specification for Electrical Insulating Oil of Mineral Origin”, American Society for Testing and Materials
- IEEE C57.106 Guide for Acceptance and Maintenance of Insulating Oil in Equipment”
- “Minimizing CPU Overheating With Liquid Immersion Cooling” Available at www.dsiventures.com.
- ASTM Standard Method D92, “Flash and Fire Point by Cleveland Open Cup Method”, ASTM International, Consohocken, PA

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