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Transforming future trends into innovations:

Siemens Alternative Insulating Liquid Transformers

Fit for the future

Transformers form an important part of all power distribution networks. They are often located where environmental protection and fire prevention are crucial. That is why Siemens increased its research on nonmineral transformer insulating liquids. These alternative insulating liquids are an investment in a safer, more ecofriendly future.

Areas of use

In ecologically sensitive locations, specific regulations apply. Transformer units filled with alternative insulating liquids are particularly suitable for installation:

- Near rivers and lakes
- Near drinking and groundwater reserves
- At high altitudes (above 3000 meters).
Reasons: environmental sensitivity and difficulties regarding soil disposal
- Wherever stringent fire safety is required

Siemens expands its portfolio Environmentally friendly and more fireresistant insulating liquids

Four types of insulating liquids

Mineral oil is the most widely used liquid for transformer insulation and for heat transfer. Its main disadvantages are its limited biodegradability, a low fire point and the fact that the resource is not renewable i.e. limited.

Silicone liquid is fully synthetic, has a high ignition temperature, a selfextinguishing behavior and the best thermal stability of the four insulating liquids stated. The disadvantages are high viscosity at higher temperatures, poor lubrication properties and limited biodegradability.

Synthetic ester liquids are derived from chemicals. At room temperature, the viscosity of synthetic ester liquids is about four times higher than that of mineral oil. The flash and fire points of synthetic esters are higher than those of mineral oil.

Natural ester liquids are made of plant seed oils (e.g. soybean, canola and sunflower). These can be broken down into saturated (chemically stable but highviscosity), single, double and triple unsaturated fatty acids (lower viscosity but unstable in oxidation). The main advantages are significantly higher flash and fire points and the best biodegradability of all the aforementioned insulating liquids.

Advantages of insulating liquid alternatives

Compared to mineral oil, all alternative insulating liquids:

- Offer higher flash/fire points
- Possess better biodegradability

Silicone liquid offers:

- best thermal stability
- self extinguishing behavior

Synthetic ester:

- has higher oxidation stability than natural ester
- is strongly hygroscopic, can absorb large quantities of moisture while retaining its insulating properties
- shows better cold temperature performance than natural ester
- is readily biodegradable

Natural ester:

- experiences less paperaging than mineral oil
- shows higher flash and fire points than synthetic ester
- as well as best renewability and is readily biodegradable

**Credit for our research:
Siemens alternative insulating liquid transformers – references**



Small power transformers

- Up to 12.5 MVA, 72.5 kV
- Natural/synthetic ester, silicone
- About 8000 units per year



Medium power transformers

- Up to 200 MVA, 238 kV
- Natural or synthetic ester
- Dresden, Jundiaí since 2008
- Linz since 2004



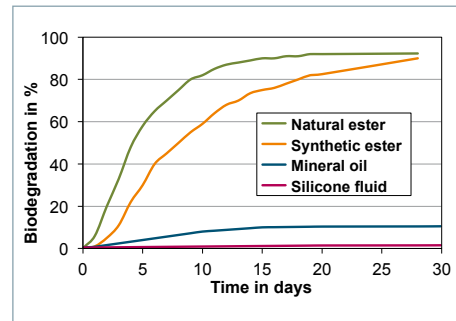
Large power transformers

- Up to 300 MVA, 420 kV
- Natural ester
- Nuremberg 2013

The challenge of change – Siemens puts alternatives to the test

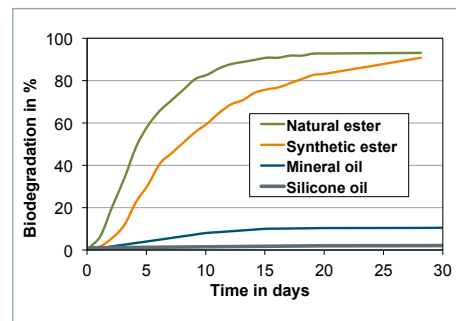
Advantage biodegradation

The Siemens Transformers R&D-department research shows: biodegradation of esters is much better compared to mineral oil or silicone liquid.



Advantage high flash and fire point

Flash and fire point analyses demonstrate the excellent values of alternative insulating liquids. This means that Siemens transformers become even safer than those with mineral oil.



Pioneering for progress

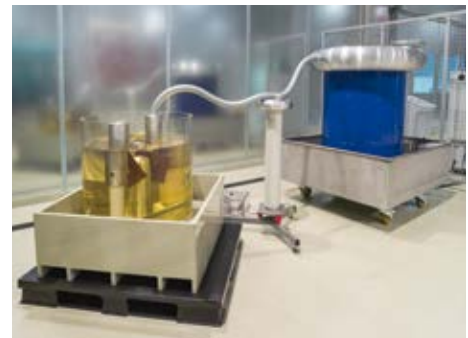
While employing alternative insulating fluids, it is not only important to make use of their advantages, but also to cope with their disadvantages:

- Higher viscosity in comparison to mineral oil
- High pour point of natural ester
- Special filling and impregnating process
- Higher price than mineral oil

Still, more than 15 years of continuous research and investigation on alternative insulating liquids makes Siemens a pioneer in ecofriendly transformer engineering.

Ongoing Development

- Further verification of dielectric strength
- Discharge and partial discharge behavior of new materials immersed in alternative insulating liquids
- Compatibility with new materials
- Aging / oxidation behavior
- Hydraulic and thermal investigations
- Static electrification
- Fire and explosion behavior in detail



Siemens researches, develops and engineers alternative insulating liquid filled transformers. This experience has already yielded impressive results, especially in the small and medium power transformers classes.

However, our expertise in the large power transformer market has also been proven by the successful manufacture of the world's first 420 kV unit using alternative insulating liquids.

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Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens AG
Energy Sector
Power Transmission Division
Transformers
Katzwanger Strasse 150
90461 Nuremberg, Germany
www.siemens.com/energy

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