



Siemens Transformers – Case Study

420-kV transformer with natural ester insulation

Innovation: Power transformer for TransnetBW (Germany)

Challenge

Sustainability, biodegradability, and renewability are the basic requirements for a modern power industry. One network operator that takes this mission especially seriously is TransnetBW. For this company, the basic conditions for network expansion are not only stable and secure energy supply for the future but also environmental compatibility and the safety of the population. These requirements impact TransnetBW from network planning down to choosing components.

In a specific case, a new transformer substation had to be erected to account for an increased energy demand. So a high-performance transformer for the extra high voltage level that is also designed to protect people and the environment was required.

“The decisive reason why we decided to install the transformer was its use of biodegradable insulation oil without harmful effects on the ground water and the environmental compatibility that this achieves.”

Dr. Michael Schäfer, head of substation equipment (Transnet BW)

TransnetBW GmbH

The company operates the transmission network in the German state of Baden-Württemberg. Its primary task is to ensure system safety at all times. TransnetBW continuously monitors and controls the energy flows within the state and energy exchange with the neighboring transmission network operators in Germany and across borders. It is the owner of the transmission network infrastructure and is responsible for maintaining and expanding its network to keep pace with demand.

The solution

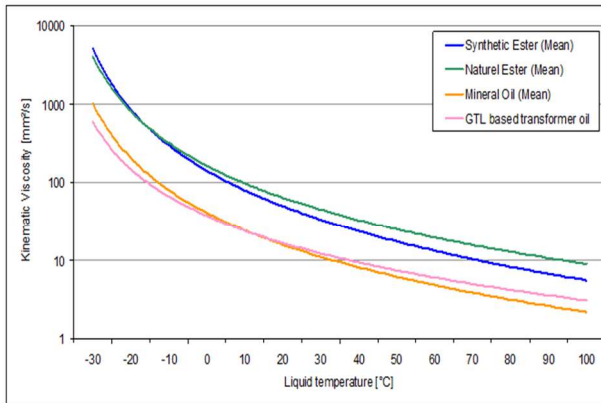
At Siemens, power transformers with alternative insulating liquids instead of mineral oil have been manufactured since 2004. The company started with units for the transmission level up to 238 kV with power ratings up to 135 MVA. After that, operational experience was gathered with larger and larger units.



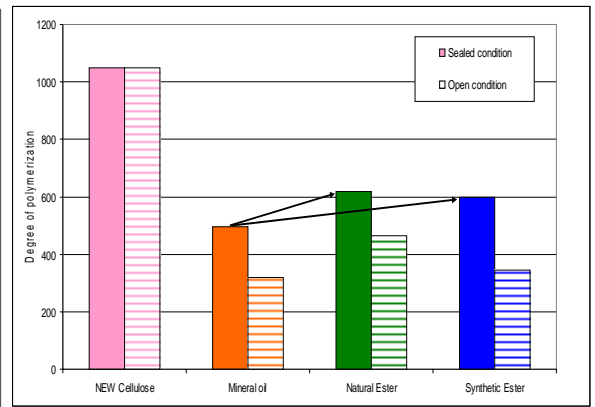
The 420 kV power transformer with a rated power of 400 MVA in the test bay and during delivery.

Natural esters are 100% biodegradable; therefore, no water hazard class needs to be assigned to this transformer. Due to the lower flammability, the transformer also has a higher fire protection class (K instead of O), so that the equipment can be used in densely populated areas and installed with optimized fire protection equipment.

There are no operating restrictions on transformers with ester oil. However, because of the relatively high pour point of natural esters, the fluidity of the material is limited at very low temperatures. The transformer for TransnetBW was designed to avoid cooling the insulating liquid below a critical limit during operation.



Kinematic viscosity of different oils versus temperature



Results of aging tests on paper impregnation

Special technical features

1. Cooling behavior

The higher kinematic viscosity of the material must be considered if natural ester is used as the insulating and cooling medium. The windings and their insulation must be specially designed. In this case, all permissible (over)temperatures have been rated according to IEC 60076-2. The quantity of energy dissipated is the same as for a mineral oil transformer.

2. Aging / service life

Aging tests show that the insulation paper ages more slowly in esters when oxygen from the air is excluded. An increased life of the power transformer can be expected, due to reduced aging of the insulation material.

3. Insulating properties

There is a lack of international standards to determine the dielectric strength of new insulating liquids depending on the types of load. Siemens therefore developed in its own laboratory tests to examine the electrical strength of the material. Based on the results, the insulation arrangement of the transformer was designed differently from mineral oil transformers. In this way, all the IEC requirements could be met. The partial discharge level for loading with 1.1 times the highest operating voltage is <10pC. This is an indication of the high electrical quality of the equipment and is the basis for an increased service life.

4. Design

Thermal, electrical, and chemical properties of ester also have an influence on the production processes; for example, accounting for the fact that the impregnation of the solids takes more time. To counter the lower oxidation stability of the material, a rubber bag was used for the transformer made of a material based on fluororubber.

Environmental protection with a future

To examine and further develop the new transformer technology during operation, systematic monitoring of all condition-related parameters of the transformer have all been agreed to with the operator TransnetBW.

"Smart solutions – such as this power transformer – are in demand for the success of the energy revolution."

Dr. Martin Konermann, general manager (Transnet BW)

Advantages of alternate liquids

Despite the slightly higher procurement costs for transformers with an alternate insulation, the advantages can be worth the investment.

- Lower risk of fire or explosion allows for lower insurance costs and lower hurdles for equipment approval.
- Compact design
- Savings on building construction:
 - Elimination of explosion protection walls
 - Partial elimination of oil sumps
 - Shorter busbar length
- Environmentally sensitive

Talk with us. We will be happy to support you in understanding the benefits of an ester insulation transformer.

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