



Siemens Transformers – Case Study

# Alternative insulation for a hydro power plant

Safe and environmentally friendly power transformers

## The Challenge

The hydro power plant Letsi in Sweden is a very special one. Built in 1967, it was not only designed to earn money, but the environment and the ethnic group of the Sami (indigenous inhabitants of the northern parts of Sweden) were respected in a very special way. Letsi was built as a cavern plant, with turbines and transformers being erected under ground.

However, after an operation of more than 40 years, a replacement of the transformers was necessary. Vattenfall as the owner of the plant is still very thoughtful in regards to this plant and emphasizes the importance of reliability and environmental friendliness of the components installed. This is why the four generator step-up transformers (GSUs) for that project were requested to be ester-filled.

*„Letsi is one of the most important Hydro Power plants in Sweden being involved in restoring the Swedish national grid in case of major disturbances. The step-up transformers are, of course, one of the most important components in such power plant. Our expectations on Siemens were therefore very high, everything must fit, time schedules must be followed etc.”*

Maria Furmark, Project Leader (Vattenfall)

## Vattenfall

Vattenfall is owned by the Swedish state. Its main products are electricity, heat and gas. In electricity and heat, Vattenfall works in all parts of the value chain: generation, distribution and sales. Vattenfall's overarching strategy is focused on transforming to a more sustainable energy portfolio. Vattenfall has century-long roots in hydro power and owns and operates over 100 hydro power plants. Being one of Europe's largest operators in hydro power Vattenfall intends to explore hydro power growth options in Europe.

## The Solution

Siemens Transformers is well known for their know-how in alternative ester fluids. Being a pioneer in eco-friendly transformer insulation, we have done extensive tests and comprehensive experience with distribution and power transformers filled with synthetic and natural ester.

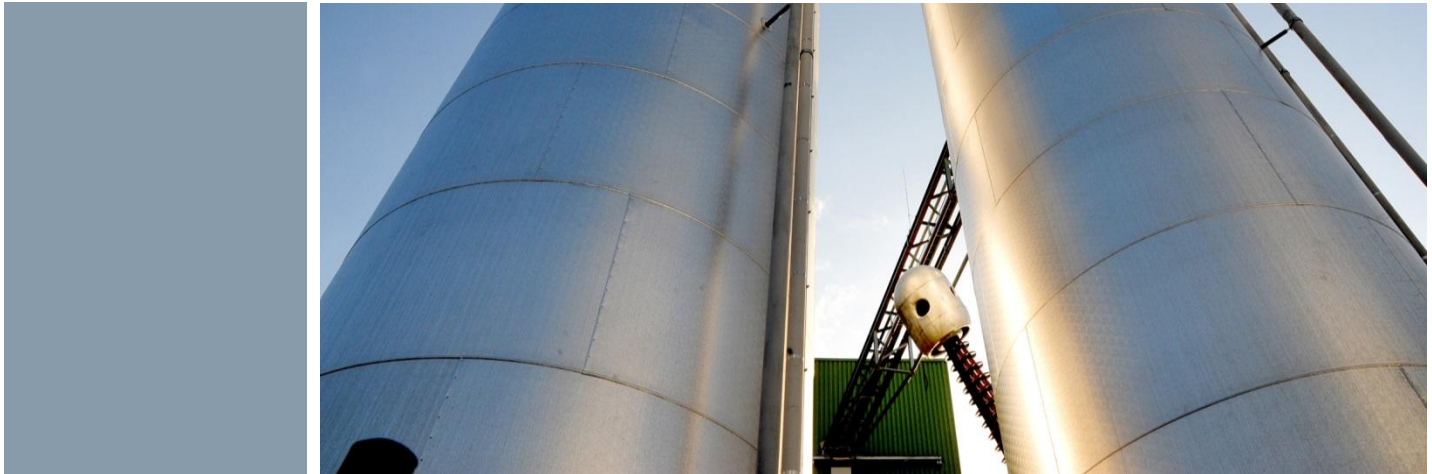


Synthetic-ester-filled power transformer in the test bay.

When replacing the transformer units that had been in service for 48 years it became a question of honour to deliver the best available products that exist today – especially as the old units were built by the same plant that was responsible for building the new ones. They had been cutting edge technology at that time, being the first 400kV units ever to be built by that plant. For the replacement, Siemens Transformers now designed and manufactured four GSUs with ratings of 121,33 (122) / 60,6 (61) / 60,6 (61) MVA and voltage levels of  $433\sqrt{3}$  / 16,8 / 16,8 kV and synthetic ester filling.

The decision was to go for Midel®7131 as an insulating liquid. This is a synthetic ester that has been successfully used for more than 35 years in distribution as well as power transformers. In addition to the design, construction and installation of the new transformers, Siemens Transformers also got the mandate for the disassembly, transport and scrapping of the old units.

[www.siemens.com/transformers](http://www.siemens.com/transformers)



### Technical features

#### 1. Design changes due to ester-insulation

Ester fluids have different physical properties than mineral oil. These properties have the impact especially on dielectric and thermal design. Due to higher viscosity of the ester there is higher hydraulic pressure drop for the same velocity. This needs to be considered for design of cooling ducts, pipe diameters and the selection of pumps. Also other parameters like thermal conductivity, specific heat and density are different and need to be considered in thermal modeling.

Design knowledge is also necessary for handling electrification properties of ester fluids.

#### 2. Impregnation process

The impregnation of insulation parts made of press board and wood can be sped up by drilling holes in big insulation parts. For optimal results, it is recommended to heat up the insulation fluid and extend the impregnation-time.

#### 3. Oil handling

All over the world alternative fluids are on the rise because of their indisputable advantages. This is why Siemens Transformers in Weiz has invested in a separate processing system and separate storage tanks for these fluids. Two 100,000-liter, double-walled tanks can be heated separately and meet all safety regulations.

A shared vacuum pump keeps the tank system under vacuum at all times; double filters with a mesh size of 2.5 µm maintain reliable filtration, and a continuous moisture measuring system ensures compliance with the required ester parameters. Screw pumps designed specifically for pressure pump approximately 3,000 to 10,000 liters of insulating fluid per hour, pulse-free, from the tank to the preparation system.

*“When looking back to what has been achieved in the project so far I must say that Siemens has fulfilled our expectations. The cooperation between us and Siemens throughout the project has been very good and Siemens’ ability to handle difficult technical matters makes you feel confident.”*

Maria Furmark, Project Leader (Vattenfall)

### Benefits of synthetic ester

The flash and fire points of synthetic ester are higher than those of mineral oil, this is one of the biggest benefits of this insulating fluid. Other advantages are that it is readily biodegradable and that it has a higher oxidation stability and demonstrates improved cold temperature performance than natural esters.

In addition, it is strongly hygroscopic in comparison to mineral oil. This means, it can absorb more moisture while retaining its insulation properties. Thanks to its special benefits, Siemens Transformers is able to design and manufacture units filled with synthetic ester that are even expected to have a longer lifetime.

### Economic advantages of alternative liquids

Despite the slightly higher procurement costs for transformers with alternate insulation media, the economic advantages can still outweigh those costs:

- Lower risk of fire / explosion => lower insurance costs or lower hurdles for equipment approval
- Savings on building work:
  - Elimination of explosion protection walls
  - Partial elimination of oil sumps
  - Shorter busbar length
- Image gain due to use of “green” equipment in marketing strategy

Talk to us. We will be happy to support you in balancing out the cost items.

If you are looking for more information on alternative fluids, check [www.siemens.com/transformers/ester](http://www.siemens.com/transformers/ester).

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