



Power Products



INSULATION
SYSTEM



INSULATION PROTECTION SYSTEMS


GUIDA TECNICA

SISTEMI DI PROTEZIONE
DEGLI AVVOLGIMENTI

TECHNICAL GUIDE

POWER FROM WITHIN





The stator's insulation system represents for the HV alternator the most critical components and requires a high level of engineering and production.

The insulating materials are exposed to high electric fields, which in combination with mechanical, chemical and thermal stresses may cause an early aging.

For instance, the high temperature may cause a chemical degradation followed by the delamination of the material. As a consequence, discharges are generated in this area, and the coil starts to vibrate. Finally, the coil is subjected to abrasion.

Hence it is very important in the design stage to consider the electrical, thermal and mechanical stresses as concurrent and related forces.

THE TECHNOLOGY



vonRoll

Mecc Alte Power Products, the division focused on High Voltage alternators, has developed in collaboration with Von Roll an insulation system at the top of technology.

It is a system based on a low viscosity epoxy resin, without any VOC (volatile organic compound), in combination with glass and Mica tapes, designed for generators up to 15,75 kV.

The system offers an outstanding behavior after ageing at high temperature with a thermal index of 191.8°C: hence beyond the class H.

Comparing this technology with the traditional insulation systems based on polyesterimide, we can see many advantages:

Very high resistance to mechanical and thermal stresses

Good thermal conductivity

Good electrical properties

High resistance to chemical corrosion

This makes our insulation system particularly good for genset applications and generally for all the applications in the harshest environments such as: marine, oil & gas, mining and heavy industry.

The Mecc Alte HVi system is REACH compliant and approved by API (the American Petroleum Institute) for harsh environments.



THE FUNCTIONAL TESTS

Defining the thermal class of an alternator is not easy. The most convenient way is to start from the Temperature Index (TI) of the main materials, which the insulation system is made of.

The temperature index of each single material is defined according to the IEC 60216 "Electrical insulating materials – thermal endurance properties" which provides the test procedures.

In this test the insulating materials are aged by means of high temperature cycles.

Basically, samples are exposed to high temperatures in an oven for a certain time, until they lose 10% of the weight of cured resin. In this way the samples are exposed only to thermal stresses.

Mecc Alte Power Products has chosen a different way, defining the thermal class by means of "Functional tests", according to the:

IEC 60034-18-31

Functional evaluation of insulation systems

Test procedures for form-wound windings

Thermal evaluation and classification of insulation systems used in rotating machines

In this, the test samples are exposed to thermal, mechanical, electrical stresses, simulating the real environment, to approve the insulation system for application in harsh environments.

TEST PROCEDURE AND RESULTS

The test has been conducted at the Von Roll Testing Labs in Switzerland, for 18 months.

The test was stopped after the low-temp sample (formette) reached a lifetime of more than 10,000 hours.

Three samples, with 5 bars insulated according to **Mecc Alte HVi insulation system** are inserted into a slot model which is a down scaled stator slot design, so called formette.

The aging temperatures used were 200, 220 and 240°C.

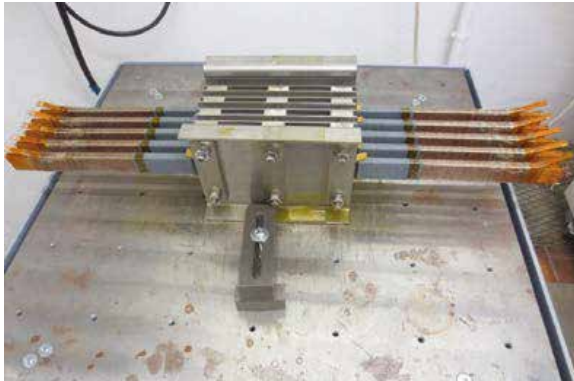
Each thermal aging cycle was followed by a test series of mechanical vibration, storage in high humidity condition, insulation resistance and high voltage test of turn insulation and main wall insulation.

THERMAL CYCLE AT DIFFERENT TEMPERATURE



62h	@ 240°C
240h	@ 220°C
744h	@ 200°C

HIGH VIBRATION TEST



20mm/s rms for 1h

DIAGNOSTIC TEST



HIGH HUMIDITY TEST



40°C / 100% r.H. for 48hrs



Turn insulation:

AC withstand test turn-to-turn, 50 Hz, 1 min, $0.2 U_N \sqrt{2} + 1kV$

Mainwall:

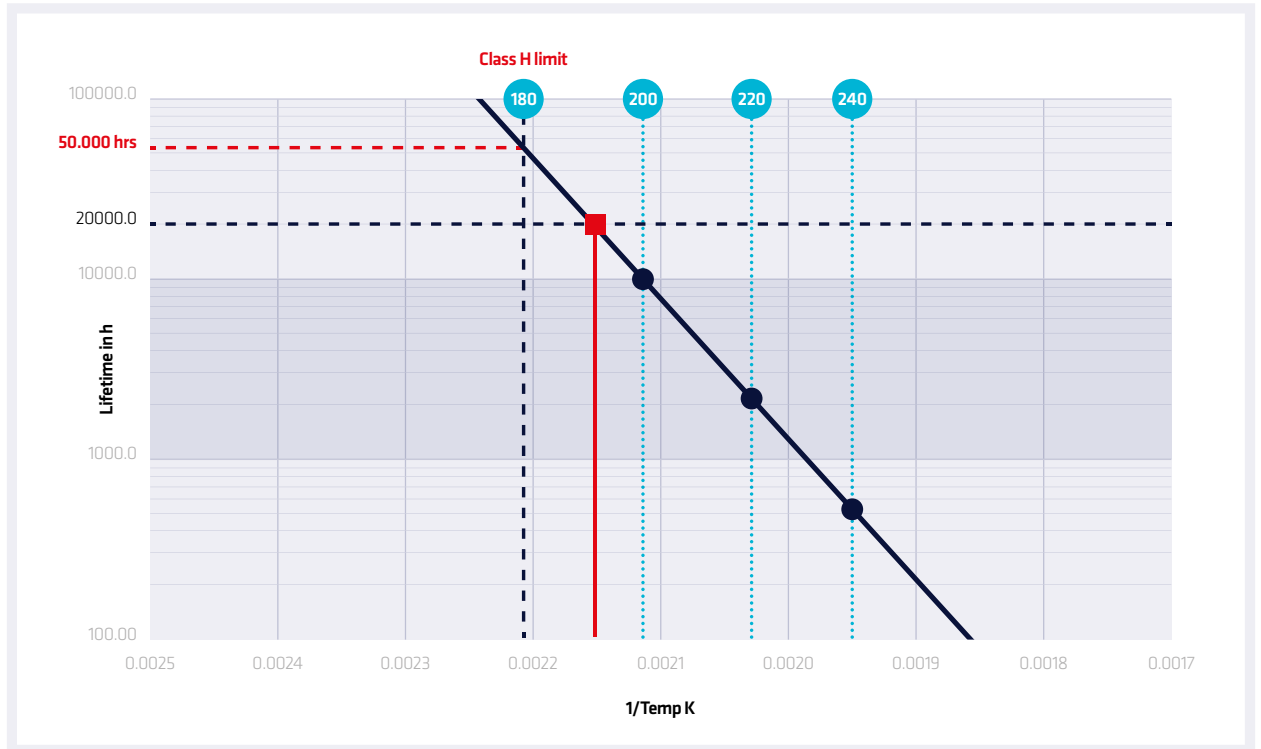
AC withstand test conductor stack-slot model, 50 Hz, 1 min, $2 U_N$

High Voltage tests reveal weak spots in turn-to-turn and main wall insulation.

Specimens are cycled until breakdown, so that a lifetime diagram of the insulation system can be obtained, then a Temperature Index (TI) of the system can be extrapolated.

The norm states that the Temperature Index (TI) correspond to a lifetime of 20.000 hrs.

The results are very good, since the Temperature Index TI reached 191.8°C exceeding the limit of 180°C: so the system can be confirmed as class H system.



In this graph we can also extrapolate the expected lifetime at different temperatures.



MECC ALTE HV INSULATION SYSTEM EXPECTED LIFE TIME

TEMPERATURE

Thermal Index	191,8°C
Class H	180°C
Class F	155°C
Class B	130°C

LIFETIME

20.000 hrs
> 50.000 hrs
> 300.000 hrs
> 600.000 hrs

This is useful when it comes to compare alternators with different insulation classes.

Often, the specification of a HV genset requires an insulation class F.

This is because of the standards imposed by the big manufactures which still have been utilizing the old technologies, or because the specifications are not updated but simply copied and pasted.

Offering a higher insulation class doesn't mean the machine is hotter, it simply means that it has been designed to withstand a higher temperature.

A class F insulation class operating at class F temperature rise (F/F) offers the same design life expectancy than a H/H. But if you consider H/F, the life expectancy of our machine is 300k hrs, 15 times higher!

Finally, these are the competitive advantages offered to our customers:

1. Operating at the same overtemperature, our H class systems offers a design life expectancy much higher than a F class system.
2. The alternator can be operated at overtemperature class H continuously offering the same life expectancy than a F/F condition. It means we can offer a more compact solution for backup application.
3. The out-standing mechanical resistance of Mecc Alte HVi system, makes it particularly suitable for that application where high vibration and high temperature are expected, such as the power generation with alternative engine.



ADDITIONAL PROTECTION

The stator's winding, depending on the application, are exposed to the aggression of oil, fuel, salt, chlorine, and due the high speed of the air inside the machine, they are also subjected to the abrasion of sand and dust.

To further increase the resistance, Mecc Alte offers in all the HV machines, an additional protection made by a bicomponent class H epoxy enamel, sprayed over the winding heads and the whole stator. It basically covers the windings with an elastic and impermeable barrier.





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