Researching Film Capacitors for Converters in Wind Power Plants

The primary goal is to manufacture components with a longer life

The Husum-based capacitor specialist FTCAP participates in the innovation cluster "Power Electronics for Regenerative Energy Supply". The project, which is coordinated by the Fraunhofer Institute for Silicon Technology in Itzehoe, researches new converter technology for wind power plants. FTCAP contributes its competences in the field of high-performance capacitors for converters to the project.

By Dr. Thomas Ebel, Managing Director, FTCAP

The increasing importance of regenerative electric power generation by wind power plants also results in higher requirements: while the electricity that is supplied must be of high quality, the power plants must also be designed for high performance and long service – even under extreme environmental conditions such as in offshore operation. Consequently, the demand for compact power electronics systems with high efficiency and a long life is high. Among the systems currently available on the market, however, there is ample potential for improvement in these respects.

The innovation cluster "Power Electronics for Regenerative Energy Supply" has therefore set the goal of improving power electronic components for wind power plants in the MW range. New components for wind power converters are being developed and tested throughout the entire industrial value creation chain: application-specific power semiconductor devices (IGBTs) for innovative connection technologies, highly reliable power modules based on sintered and copper wire bonding technology, efficient switching topologies and drive circuits as well as new mechatronic approaches form the basis for a new powerstack generation. The goal is to develop a 3-phase powerstack demonstrator with three power modules (one module for each phase) that is suitable for use in a back-to-back full-power converter. The target power rating is 1 MW.

Figure 1: FTCAP_Filmkondensatoren_Windkraft.jpg: As part of a research project the Husum-based capacitor specialist FTCAP is researching new, long-lasting film capacitors for converters in wind power plants

Innovative capacitors for wind power plants

Both the power modules and the capacitors will play a decisive role in the development of this system: the power converter in a wind power plant consists of two converter units. These, in turn, contain two power modules, which are connected to each other by a DC link equipped with capacitors and supply the entire power converter with electricity. The capacitors store energy that can be used in the case of a mains failure to ensure uninterrupted operation. Consequently, the system components that are subjected to the greatest load are the power modules and the capacitors, which must be as robust as possible. The main challenge with respect to capacitors for converters in wind power plants is the service life. A wind turbine should be able to operate for many years without the need for maintenance. This requires innovation with respect to the capacitors, as well.

Figure 2: Windkraftanlagen_Kondensatoren_FTCAP.jpg: The main challenge with respect to capacitors for converters in wind power plants is the service life – a wind turbine should be able to operate for many years without the need for maintenance. Picture © pedrosala – Fotolia

Innovation, however, also involves stumbling blocks – and there are many of these in the case of wind power plants. In this application, the capacitors are subjected to diverse stress factors: humidity, extreme temperatures and high ripple currents can impair the functionality. Depending on the type of capacitor, this results in different potentials for error: excessive ripple currents, for example, can damage electrolytic capacitors beyond repair. That is the worst case scenario, which of course has to be prevented. But also the normal detoriaton process of the capacitors can become a problem in wind power plants. The

fact is that in normal operation a capacitor does not fail all at once – instead, this component is subject to a gradual detoriaton process, which results in a continuous decrease in performance. It is therefore necessary to examine not only the mechanisms and causes of such a decrease in performance, but also the effects of the detoriation process on the performance of the overall system.

Exploring the promising potentials of PEN-HV

In the search for a high-performance capacitor for wind power plants, FTCAP is exploring the promising potentials of the high-temperature dielectric PEN-HV within the framework of the research initiative. PEN-HV combines the self-healing properties and the dielectric strength of oriented polypropylene (OPP) with the mechanical and thermal advantages of polyethylene naphthalate (PEN). This innovative material allows even better isolation of the capacitors for use at temperatures of up to 125 °C. FTCAP will test film capacitors equipped with PEN-HV and compare them with two standard products. Our hope is that the new technology will result in even more reliability and a significantly longer service life. At the same time we want to achieve an even more compact design of the capacitors – after all, the space in the nacelles of wind turbines is very limited. The reduction of the size of the capacitors will be possible especially due to the high temperature resistance of the new material, according to the experts: if the capacitor can also withstand high temperatures, the size of the cooling systems can be reduced or they can even be eliminated altogether.

Whether PEN-HV will indeed pave the way for innovative wind power capacitors will become apparent within the framework of the research project. The experts at FTCAP will examine these and other capacitors in extensive tests. They will test criteria such as the winding parameters, the dielectric strength and, of course, the temperature resistance. But the storage life in combination with different encapsulations and housings, as well as the self-extinguishing properties of the different materials are also relevant. It will still take some time to determine the optimal solution: if everything goes according to schedule, the demonstrator should be completed and tested by the end of 2015.

Innovation cluster "Power Electronics" – the project partners

The consortium consists of the companies, Danfoss Silicon Power GmbH, FTCAP, Reese & Thies, Senvion SE and Vishay Siliconix Itzehoe GmbH in Schleswig-Holstein as well as the academic facilities of the Christian-Albrechts University in Kiel, the Kiel University of Applied Sciences, the Flensburg University of Applied Sciences and the West Coast University of Applied Sciences in Heide, Germany. The Fraunhofer Institute for Silicon Technology in Itzehoe is the coordinator of the innovation cluster in Schleswig-Holstein. The interests of the Federal State of Schleswig-Holstein are represented by the WTSH Corporation for Business Development and Technology Transfer. Subsidisation at the regional level is provided by the "Programme for the Future of the Economy" and the Ministry of Economic Affairs, Labour, Transportation and Technology of Schleswig-Holstein.

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http://www.fraunhofer.de/de/institute-einrichtungen/kooperationen/innovationscluster/leistungselektronik-regenerative-energieversorgung.html

www.ftcap.de