The fault current limiters for the three phases of the electricity grid are housed separately in cryogenic containers. Closed cooling systems ensure the low temperatures. The whole system is so compact that it can be housed in a prefabricated container.

An inductor is connected parallel to the fault current limiter for every phase.

Thomas Janetscheck presents the ASSIST project at the ZIEHL conference in Munich.

Stadtwerke Augsburg testing superconducting fault current limiter

The ASSIST project shows how decentralised feed-in systems can be safely integrated into a medium-voltage network. Since 15 March, a superconducting fault current limiter ensures that the electricity fed from a cogeneration engine test rig into the electricity grid belonging to Stadtwerke Augsburg municipal utility company is protected against short circuits. Last week, Thomas Janetscheck from Stadtwerke Augsburg presented the system at the ZIEHL V superconductor conference in Munich.

In the ASSIST project, engineers from Stadtwerke Augsburg and Siemens are testing resistive fault current limiters through which electricity directly flows during the three phases of the grid being protected. A closed cooling system brings the fault current limiters at minus 196 degrees Celsius into the normal superconducting operation. In this state, they are invisible for the current flow, since the alternating current resistance is extremely low. However, if the current exceeds a threshold when there is a short circuit, this causes a so-called quench. The superconductivity breaks down and within milliseconds an electrical resistance builds up that very effectively suppresses the current flow. The suppression occurs so quickly – and stronger than is actually desired – in order to maintain, for example, specific operating conditions. For this reason, inductors connected parallel to the superconductors provide a bypass. This guarantees the current flow planned in the event of a short circuit. The fault current limiter works completely independently and is intrinsically safe. After a short cooling period, it automatically resumes operation without further maintenance.

A feature of the resistive fault current limiter used in ASSIST is its high intrinsic safety. It can be built very compactly and achieves considerable current limitation. A decisive factor is that it does not adversely affect the stability of the electricity grid. This differs from the inductors commonly used today, which have a continuously high resistance. On average, the loss of electrical power per inductor is around 25 kilowatts. “In the system used by Stadtwerke Augsburg, the superconducting fault current limiter saves about 36,000 kWh each year,” said

Thomas Janetscheck. “For design reasons, the power flow is secured in both directions. The closed cooling circuit eliminates the need to refill the system with liquid nitrogen,” added Peter Kummeth, project manager at Siemens Corporate Technology.

The system is being operated in the field trial until 2017, whereby the engineers are testing the functionality and reliability of the new technology under practical conditions. A cooperation agreement between Siemens and Stadtwerke Augsburg foresees the operation of the fault current limiter for several years in order to collect operational experience in regard to economic aspects.

Fault current limiters can be used in diverse ways

Fault current limiters are already commercially used in isolated cases in power plants. They can play an important role in future electricity networks with many decentralised feed-in points and intermittent suppliers. They enable several electrical sub-networks to be connected together, thereby increasing the reliability and stability of the grid. In addition, when superconducting fault current limiters are used for connecting multiple sub-networks or decentralised energy suppliers, they also eliminate the additional expense for replacing or upgrading electrical components for strengthening the networks.

As an alternative to resistive fault current limiters, inductive types are also being developed. Here, the superconductor is coupled via an iron core transformer. There are two variants with either shielded or saturated iron cores. The advantage of inductive fault current limiters is their lower cooling load. The cooled superconductors are not connected in series and do not have grid electricity flowing through them. However, a major disadvantage of these fault current limiters is that they require a considerable amount of material and thus are very heavy, large in size and have relatively low suppression (saturated iron core).

Gathering of superconductor experts

Every two years, superconductor experts meet at the “Future and innovation in energy technology with high-temperature superconductors” conference – known as ZIEHL for short. This year's conference, which took place from 15 to 16 March 2016, was held for the first time in Munich. The scientists were satisfied with how their field of research is progressing and its prospects for the future. For example, in the network technology field advances have been made with fault current limiters, high-performance cables and energy storage flywheels. In particular, superconductors can utilise their special advantages when high performances are required in compact and lightweight rotating machines. The researchers therefore see potential in engines for aircraft and ships or in the generators used in very large wind turbines. Some products using this innovative technology are already commercially successful, such as fault current limiters and high-current rails for industrial applications.

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