

110 MVA at 20 kV: Prototype demonstrates potential of Superconducting Power Cables

The superconductor-specialists at Nexans Deutschland GmbH demonstrated a remarkable technical feat at the end of last year: Their successful test of a superconductor cable rated at 3.2 kA demonstrated a transmission power of 110 MVA at the 20 kV level.



Power company ENDESA and partners from academia

The project was initiated by Spanish power company Endesa S.A. In addition to Nexans,

the Spanish research institute ICMAB-CSIC (Instituto de Ciencia de Materials de Barcelona - Consejo Superior de Investigaciones Científicas) as well as the Universitat Autònoma de Barcelona (UAB) were involved. After the successful conclusion of prototype testing, the project partners now plan to bring this technology to the grid.

Advantages of Superconductor Cables

In addition to being able to increase transmission capacity without raising the voltage level, superconductor cables exhibit various properties that are of interest to network operators: Superconductor cables do not exhibit external magnetic fields, due to their superconducting screen layer: In the screen layer, a current equal in magnitude and opposite in phase to the transport current cancels the magnetic field of the transport current. In addition, the cables are actively cooled by liquid nitrogen, which makes them thermally independent from their surroundings. The combination of these properties allows for very close spacing of superconductor cables, as there are no interactions (thermally or magnetically) between cable phases.



One of a kind test field in Hannover

Successful prototype testing took place in the test field of the Superconducting Cable Systems group in Hannover, Germany. There, state of the art high voltage equipment along with a sophisticated cooling system enables extensive test cycles: Among other things, the ENDESA cable prototype witnessed 10 day-long load cycles. Each of the cycles saw the cable being subjected to a voltage of 23 kV ($2 U_0$) for the duration of the 10 day test, while the rated current of 3200 A was on for a 8 hours at a time, with a 16 hour break before being switched back on.



Market availability of superconductors keeps increasing

The past few years have seen an ever increasing quantity of commercially produced superconductors. These superconductors that are used in cable applications are supplied in tape form. For the ENDESA project, the tapes were made from Bismuth-Strontium-Calcium-Copper-Oxide (BSCCO), which is also known as first generation (1G) superconductor. The commercial production of Yttrium-Barium-Copper-Oxide (YBCO) has been continuously increasing over the past few

years. This has also led to a reduction in the superconductor cost, a development that will ensure that superconducting cables will be commercially viable in the near future.

Nexans Superconductor specialists are leading the way

The successful testing of the ENDESA cable is just one in a long list of successes and firsts for Nexans Superconducting Cable Systems. Back in 2008, a 138 kV high voltage cable was commissioned in the network of the Long Island Power Authority (LIPA). The 600 m long system is the longest cable system installed so far, and continues to be part of the LIPA grid, where it is undergoing a long-term field test. At a rated current of 2400 A, the cable has a rated transmission power of 574 MVA. The three phases of the cable are separated by only about one meter, allowing for a very compact right of way.

Both the ENDESA Prototype cable, as well as the 600 m long cable installed in the LIPA grid, featured first generation (1G or BSCCO) superconductor. Projects featuring second generation (2G or YBCO) superconductor were just as successful: The Super3C (Superconducting Coated Conductor Cable) successfully demonstrated the use of YBCO in a superconducting power cable prototype. It also underwent fault current testing, demonstrating the safety of superconducting power cables under adverse conditions sometimes seen in the grid. The feasibility of second generation tapes in high voltage cables was demonstrated in Hannover back in 2007, when a 30 m prototype of a 138 kV cable using YBCO was successfully tested.