Project Report 2006

MgB2-based Superconducting Magnetic Energy Storage - Investigation of H2-Related Aging Effects & Compatibilities

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Objectives: short, medium and long term

In the long term, a substantial increase of the contribution of renewable energy sources RES will eventually increase the need for storing large amounts of excess RES energy and for balancing supplies and demands in the electrical grid. Beside currently available and actively pursued storage technologies for different supply durations such as super capacitors, batteries, flywheels or compressed air, a new multi-functionality hybrid energy storage concept, LIGHYSMES, has been recently proposed. This LIQHYSMES approach combines the use of LIQuid HYdrogen (LH2) as the primary, high-density energy carrier with Superconducting Magnetic Energy Storage (SMES) for a fast and efficient buffering. In the medium term the installation of a small test set-up is currently underway which allows developing basic technologies both for regenerative H2 liquefactions processes and MgB2-based magnets operated in an LH2 bath. In the short term, our primary goal was to exclude aging effects due to H2 diffusivities or embrittlement for the anticipated long-term operation of the SMES. Therefore several components needed for the H2 liquefaction and storage as well as superconducting parts (wires and joints), mechanical support structures and electrical elements (e.g. insulations or contacts) of a magnet coil have been exposed to direct contact with LH2 and qualified regarding their ability to withstand H2-related aging and embrittlement.

Brief summary of work carried out

Samples of the various materials needed for the H2 liquefaction or construction of the superconducting magnet were catalogued, photographed and visual inspected before and after the test in LH2 bath. Additionally Vickers hardness and bend tests before and after the LH2 aging have been made on some mechanical support structures like stainless steel, G10 or resins. As well as this, before and after the LH2 aging test a short MgB2 superconductor sample and a single layered test coil wound with the MgB2 wire were electrically characterised by critical current measurements at liquid Helium temperatures as a function of the external magnetic field. The LH2 aging test was performed in a closed cryostat with all selected samples inside. The cryostat was filled with liquid hydrogen. The samples were exposed to LH2 for about 5 - 6 days.

Main achievements intended for publication

The results of this test will feed into the design of the small test set-up and may be published at a later stage and in a wider context. (numerical documentation of test proceedures and results see extra data on excel work sheet)

Difficulties encountered

No difficulties were encountered during the LH2 test, only the duration of the aging test was too short or, in other words, the amount of LH2 was too small. For in depth knowledge about LH2 related aging effects and compatibilities the tests should be repeated for a prolonged period.

Further comments

Collaborating person at KIT passed away during reporting on user project experiment and results.