Application 2006

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

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A new hybrid energy storage concept for variable renewable energy, LIQHYSMES, has been proposed which combines the use of LIQuid HYdrogen (LH2) for large scale longer-term stationary energy storage with Superconducting Magnetic Energy Storage (SMES) for providing high power over short time scales like seconds or minutes. The SMES using the new MgB2 superconductor can be operated in the LH2 bath which allows jointly utilizing the cryogenic infrastructure thereby reducing losses and costs.

Superconducting parts (wires and joints), mechanical support structures and electrical elements (e.g. insulations or contacts) of a magnet coil have to be qualified as regards their H2 compatibility: Aging effects due to H2 diffusivities or embrittlement have to be excluded for the anticipated long-term operation of the SMES. If necessary, changes to definitely qualified materials & components and/or adaptations e.g. by coatings have to be made. Materials and components will be investigated for an operation in direct contact with LH2. Moreover, some parts (e.g. current leads) have also to be evaluated for the whole temperature range from 20 K to room temperature.

Components provided by Columbus Superconductors will be exposed to H2 under different conditions at KIT and thereafter analysed by Columbus Superconductors as regards H2-related aging effects & compatibilities:

Components:

MgB2 wires has been realised in various shapes and dimensions and also with different sheathing and composing materials for different applications. In the use in SMES application, which is substantially, even if not only, a superconducting magnet, the typical configurations are flat or square like cross sectional wires, to be better wound in solenoid shapes. Columbus produces several wires with these characteristics (see attachment)

Also, other sheathing materials have been used, for example Titanium and Titanium alloys, to obtain higher strength and lower losses in AC regime (which can be interesting also for the

SMES application during the charging and de-charging time) due to reduced hysteresis losses (see attachment)

This kind of information gives an idea of the fatigue capability of the wires. It is an important information because the charge Ł?? discharge phases is the prerogative working way of a SMES. Due to magnetic pressure, the wire must bear cycle of strain-release. It well known how Hydrogen tends to creep into metals and fatigue cracking is enhanced, thus leading, in this case, to an unwanted and (if not previously studied) unknown degradation of critical currents, bringing to a complete failure of the system.

Exposure of Components under Different Conditions:

- 20-bar-GH2 at
- room temperature for at least 2 weeks
- 20-bar-GN2 at room temperature for at least 2 weeks
- 20-bar-GH2 at the temperature of the liquid nitrogen (LN2) for at least 2 weeks
- LH2 for at least 2 weeks

Analysis of Potential Degradations:

- Microscopic analyses
- Electrical and superconducting properties
- Mechanical testing
- Micro hardness

Major Outcome:

Report on “MgB2-based Superconducting Magnetic Energy Storage - H2-Related Aging Effects & Compatibilities” to be delivered by Columbus Superconductors