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Theoretical and experimental investigation of R&W and W&R SMES coils wound with large-scale MgB2 Rutherford cables operated around liquid hydrogen temperature

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We have been developed the system called Advanced Superconducting Power Conditioning System (ASPCS) composed of Superconducting Magnetic Energy Storage (SMES), fuel cell and water electrolyzer for effective use of renewable energy such as wind and solar power generation. The SMES coils are wound with superconducting cables with large current capacities of kiloamperes (kA). We have been investigating about the SMES coil using large-scale Rutherford-type conductors made of commercially-available MgB_2 wires. The MgB_2 wires has critical temperature above boiling temperature of hydrogen, showing enough critical current (I_C) for practical application in self field of energy storage devices. Due to strain sensitivity even before heat treatment for MgB_2 production, the design for large-scale Rutherford cables both in wind and react (W&R), react and wind (R&W) method applied to coil fabrication has to be done cautiously to prevent the degradation of the I_C by optimizing design parameters such as twist pitch and cable compaction. Especially for the R&W method using heat-treated wires, other factors like handling during coil production process which might affect the conductor and coil I_C should be also considered. To evaluate the applied strains during manufacturing process, we conducted theoretical investigation on strains applied to individual filaments caused by wire-bending. We developed a test coil designed for R&W method based on analyzing those factors and the result of experiment. Furthermore, we have measured the coil I_C-B-T characteristic, which will be compared to those of other test coil made with W&R method.

Keywords: MgB2, SMES, Rutherford cable, Ic-B-T characteristic