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Off-Power Operation of prototype on-board HTS Magnets for EDS-type Maglev Trains

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HTS magnets with magnetomotive force >360 kA and off-power operation time longer than 1 hour have been achieved for a prototype Maglev train. Off-power operation means no power source, no cryocooler, no vacuum pump and no more cryogen supply in the vehicle, like permanent magnets. Such operation mode was realized based on the following techniques: (1) persistent current mode (PCM) operation of HTS poles which are serial connected stacks of HTS coils; (2) solid nitrogen which serves as the so-called "thermal battery"; (3) coupled optimization of electromagnetic-mechanical-thermal design of the magnet structure.

Off-power operation provides the feasibility of levitating a small (<3 tons) prototype vehicle with no on-board power. And it also enhances the operation reliability for commercial running of real-scale maglev trains during fault conditions.

These magnets are conduction-cooled by GM cryocoolers in current project for a 200-meter test track. Each magnet contains two independent magnetic poles. And intrinsic decay rates around 1%/day has been realized. Turn-to-turn resistance of coils is 2-5 μΩ·cm2. This is a compromise of self-protection ability and potential eddy-current loss. Consequently, the initial energization time is several tens of hours. This is proposed to be acceptable by the authors since the recharging period is about 1 week and several hours are sufficient to finish the recharging process.

These magnets are produced for studying electrodynamic suspended (EDS) Maglev trains. In this route, the biggest achievement has been accomplished in Yamanashi test line. This type of maglev is promising for future high-speed train system, especially with the speed higher than 600 km/h and even 1000 km/h.

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