APP9-1

Numerical studies on the dynamic responses of levitated high-temperature superconductor with a strongly coupled thermo-electromagnetic model

*Changqing Ye[1], Guangtong Ma[1], Tianyong Gong[1,2], Wenjiao Yang[1], Kun Liu[1]

State Key Laboratory of Traction Power, Southwest Jiaotong University, Chengdu, China[1]
College of Electrical Engineering, Southwest Jiaotong University, Chengdu, China[2]

In this paper, we present a 2-D numerical model of based on H-formulation and nonlinear E-J relationship to study the dynamic responses of a high-temperature superconductor (HTS) levitated above a permanent magnetic guideway (PMG). Being different from the existing related models and results of this subject, the effects of thermal are taken into account by a strong coupled model of electromagnetic, thermal and force. The levitation forces are calculated by finite element software and then the vertical motion of the levitated HTS subject to external disturbance is characterized by a second-order dynamic equation which couples the electromagnetic model via the levitation force. We study the thermal effects on the vertical dynamic characteristics of the HTS levitated above a Halbach-derived PMG. The obtained results reveal that this strongly coupled model can better simulate the dynamic response of HTS levitation system.

APP9-2

A man-loading hybrid maglev vehicle employing PML and SML

*Ruixue Sun[1], Jun Zheng[1], Jipeng Li[1], Haitao Li[1], Zigang Deng[1]

Applied Superconductivity Laboratory, State Key Laboratory of Traction Power, Southwest Jiaotong University, Chengdu 610031, P. R. China[1]

In a bid to enhance the competitiveness of maglev technology advancing in passive stability and simple structure, a hybrid maglev system employing permanent magnetic levitation (PML) and superconducting magnetic levitation (SML) was developed. Based on the magnetic rail of "Super-Maglev" system, the hybrid maglev vehicle (1.34 m in length, 1.0 m in width) was designed for one passenger with a levitation height of 10–30 mm. It is composed of PML part and SML part, and a maglev frame is employed to support the vehicle body and connect the maglev components. The PML part with repulsive force is designed to support the main load, and the SML part with pinning forces is used to guarantee the lateral stability and support the weight of the maglev frame. The PML part is fixed to the maglev frame by linear sliders, and is able to move freely in the vertical directions. The bogies are designed and installed for basic curve negotiation function and the damper function. The driving is accomplished by a linear induction motor. The linear motor is installed at the middle of the magnetic rails, interacting with the induction plate mounted on the SML part. Measurements of static load characteristic of the hybrid maglev vehicle were performed. The rated load of this hybrid maglev vehicle was designed as 400 kg with small size maglev components, when the levitation height of PML part was 28 mm and the field cooling height of SML was 20 mm. The operation results imply that the man-loading hybrid maglev vehicle possesses excellent advantages of load ability and passive stability at the same time. The system component and test data are reported in detail in this paper.

Keywords: man-loading, hybrid maglev, permanent magnetic levitation, superconducting magnetic levitation

APP9-3

Operating characteristics of high-temperature superconducting maglev under a low-pressure environment

*Wuyang Lei[1], Nan Qian[1], Jun Zheng[1], Yong Zhang[1], Lian Jin[1], Shijie Bao[1], Zigang Deng[1]

Applied Superconductivity Laboratory, State Key Laboratory of Traction Power, Southwest Jiaotong University, Chengdu 610031, P. R. China[1]

For higher speed, the evacuated tube transportation (ETT) was proposed to be a hotspot. The high-temperature superconducting (HTS) maglev with self-stable, low noise and high efficiency is a perfect choice to be employed in the ETT system. A preliminary assessment on the low-pressure effect on the safety and stability of the HTS maglev vehicle was conducted. The experiments were based on the latest research result of a 45-m-long HTS Maglev-ETT Test System. The operating characteristics including lateral displacement (LD), damping and vibration acceleration under different pressure were investigated under different field-cooling-height (FCH) conditions. Experimental results show that the maximum lateral displacement (MLD) will be obviously decreased at 20 kPa and 60 kPa, compared to the condition of 100 kPa. It implies that the low-pressure environment is beneficial to improve the operating safety. The results provide basic data of the pressure effects on the HTS maglev system which proves that the low-pressure environment can improve the operating characteristics particularly on the performance of the MLD and further demonstrate the superiority of the HTS Maglev-ETT. Finally, a comparatively appropriate FCH (30 mm) is proposed for low-pressure environment, which will make reference for the future study and application of the HTS Maglev-EET.

Keywords: HTS maglev, low pressure, operating characteristics, damping

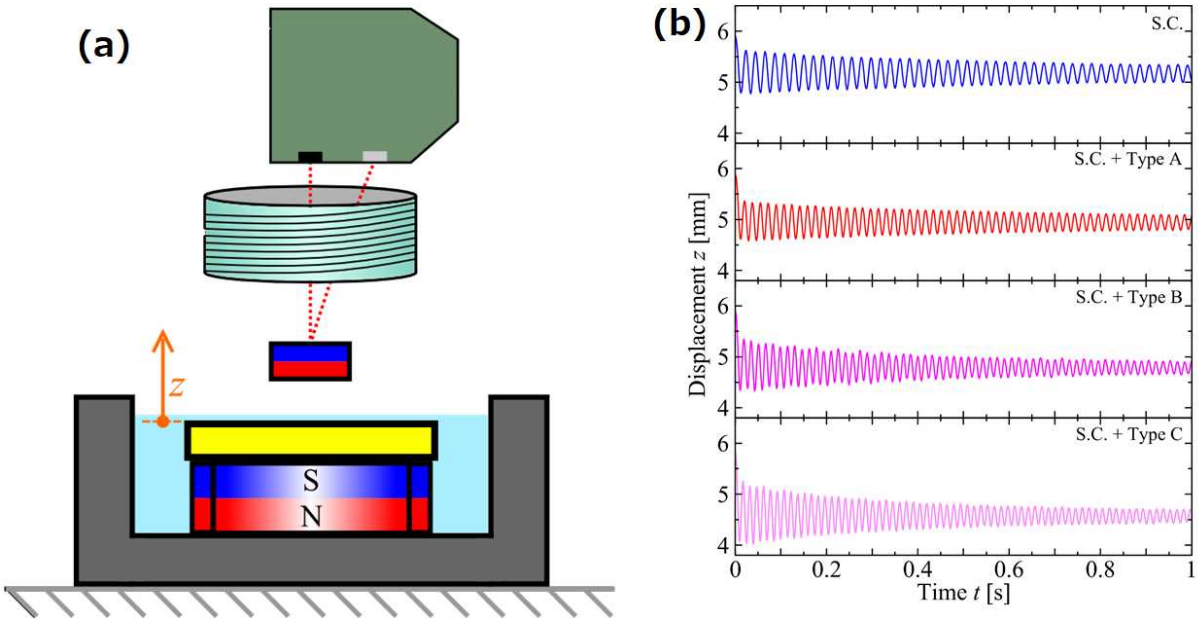
APP9-4

Levitation Stability of Superconducting Stator adding Ring Shaped Magnet

*Muneo Futamura[1], Ryo Shindo[1]

Akita Prefectural University[1]

High magnetic rigidity is needed in order to make optimum use of the high performance of superconducting levitation. In this study, we proposed a hybrid stator comprising a superconductor and a ring-shaped permanent magnet, and measured the oscillation characteristics of a magnet levitating above various hybrid stators.
The magnetic force between the hybrid stator and a levitating magnet was measured by displacing at semi-statically. By adding a ring shaped magnet, the vertical attractive magnetic force and stiffness were increased compared with those of a simple superconducting stator. The magnetic force showed a hysteresis against the displacement of the levitating magnet. It was observed that the hysteresis energy loss was larger as the adding ring magnet was thicker.
The oscillation frequency of levitating magnet above the hybrid stator is higher than that of the simple superconducting stator. With the hybrid stator, a faster decay due to the hysteresis energy loss and Small amplitude from the Enhanced magnetic stiffness were observed. An improvement in the stability of the levitating magnet is realized by the hybrid stator using a superconductor and a ring-shaped magnet.



Keywords: Superconducting Levitation, Damping Oscillation, Magnetic force, Superconducting Hybrid Stator