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Dynamic Response of HTS Pinning Maglev System Under High Frequency Excitation

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The world's first full-sized high-temperature superconducting (HTS) Pinning magnetic levitation (maglev) engineering prototype train was officially launched in SWJTU, Chengdu, China in 2021. This prototype provides strong proof for the feasibility of engineering application of HTS pinning maglev in civil train. This prototype shows the basic load and low speed operation capability of HTS pinning maglev train, and the next important issue should be its levitation stability and dynamic behaviors. Unlike traditional vehicle system which most focus on the low frequency excitation due to its low natural frequency and usually ignore the influence of high frequency excitation on the train dynamics, the unique phenomenon of flux flow and flux creep inside the superconducting bulks complicates this case for HTS pinning maglev system, especially for the ultra-high speed this prototype aimed to achieve. To study the dynamic response and levitation stability of the HTS pinning maglev under high frequency, a series of experiments have been carried out. Firstly, the vertical and lateral levitation stiffnesses of a HTS pinning system were measured by static experiment. Secondly, the external excitations with different frequencies, intensities and directions were added to the system by a vibration table, and the dynamic response signals were collected. Finally, the effects of high frequency excitation on the dynamics response and levitation stability of the HTS pinning maglev system were gained by signal analysis. The result verified that the HTS pinning maglev can effectively isolate the high frequency vibration, but some excitations can affect the dynamic performance of the system. This study suggests the smoothness requirement of the operating line and the limitation of the operating speed, as well as providing references for future dynamic studies of HTS pinning maglev system.

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