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3D Electromagnetic Analysis of Tubular Permanent Magnet Linear Launcher

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A short stroke and large thrust axial magnetized tubular permanent magnet linear launcher (TPMLL) with non-ferromagnetic rings is presented in this paper. Its 3D finite element (FE) models are established for sensitivity analyses on some parameters, such as air gap thickness, permanent magnet thickness, permanent magnet width, stator yoke thickness and four types of permanent magnet material, ferrite, NdFeB, AlNiCO5 and Sm2CO17 are conducted to achieve greatest thrust. Then its 2D finite element (FE) models are also established. The electromagnetic thrusts calculated by 2D and 3D finite element method (FEM) and got from prototype test are compared. Moreover, the prototype static and dynamic tests are conducted to verify the 2D and 3D electromagnetic analysis. The FE software FLUX provides the interface with the MATLAB/Simulink to establish combined simulation. To improve the accuracy of the simulation, the combined simulation between the model of the control system in Matlab/Simulink and the 3D FE model of the TPMLL in FLUX is built in this paper. The combined simulation between the control system and the 3D FE model of the TPMLL is built. A prototype is manufactured according to the final designed dimensions. The photograph of the developed TPMLL prototype with thrust sensor and the magnetic powder brake as the load are shown. It can be seen that the simulated voltage waveforms and current waveforms of the winding, the simulated frequency curves of the mover with the movement range from -6mm to 6mm are accordant with the tested results. Hence the correctness of established FE models is further verified, and the feasibility of proposed control strategy is testified. The frequency response is rapid. Thus, the great dynamic performance of the prototype, effectiveness of the adopted control strategy and the corresponding combined simulations based on the 3D FE model are verified.

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