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Flux Characteristics Analysis of a Single-phase Tubular Switched Reluctance Linear Motor

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This paper analyzed the flux characteristics of a single-phase tubular switched reluctance linear motor (TSRLM) based on magnetic equivalent circuit (MEC) method. The stator is composed of a stator sleeve and a bread type winding. There are two teeth on the stator. The bread type winding is embedded in the slot of the stator, which can improve the coil factor and decrease the end effect. The mover is mainly composed of the mover teeth rings and the mover yoke sleeve. Three mover teeth rings are uniformly distributed on the mover yoke sleeve. The single-phase TSRLM is divided into five different parts, which are the teeth of the stator, the yoke of the stator, air gap, the teeth of the rotor, and the yoke of the rotor. The reluctance of every part is expressed in analytical formulas at five special mover positions. The flux linkages at five special mover positions are calculated by magnet tube method and Gauss-Seidel iteration method which takes the saturation into consideration. It gives the analytical expressions of reluctances of each part in the single-phase TSRLM. Therefore, the flux linkage at certain mover position and certain current can be calculated with MEC method. A high order Fourier series is used to map the nonlinear relationship between flux linkage, current and mover position with the flux linkage data calculated by MEC method. The calculated flux linkage is consistent with 3D finite element method (FEM) and experimental results. Three specific currents are chosen to compare the generated static thrust, which are 2A, 4A, and 6A. The dynamic and static performance of the simulation utilized with MEC method are consistent with those in experiments, which verifies the accuracy of the MEC method proposed in this paper. The proposed MEC method can obtain the flux linkage data quickly under acceptable accuracy.

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