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Design and Electromagnetic Analysis of a Multi-Stage Induction Coilgun System for Heavy Projectile

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Electromagnetic launchers using pulsed power are more advantageous than chemical guns because they use electromagnetic force to accelerate amateurs at a higher velocity. The railgun can accelerate a light projectile to hypervelocity, while the induction-based coilgun is used for accelerating heavy projectiles (weighing hundreds of kilograms). The induction-type coilgun systems are therefore a subject of considerable research interest. In particular, the capacitor-driven multi-stage induction coilgun, which features almost no physical contact between the barrels and the projectile, has a longer gun lifetime as well as higher efficiency when compared to other electromagnetic launchers. The coilgun system have high efficiency but experience electromagnetic forces in coil assembly parts. It is therefore necessary to analysis the electromagnetic characteristics of the coilgun system to provide high efficiency and reliability.
In this paper we present design and electromagnetic analysis of a multi-stage induction coilgun system for heavy projectile.
The final goal of the coilgun system is to accelerate the heavy projectile more than 20 m/s with high efficiency. The fundamental specifications of the induction type coilgun system was investigated via mathematical analysis model using MATLAB considering pulse power module. The electromagnetic characteristics of the multi-stage coilgun system was analyzed using electromagnetic analysis using FEM programs. The electromagnetic analysis results were compared with mathematical analysis results.
As the results, voltage, current, force, velocity, and projectile acceleration of the multi-stage coilgun system were very similar to mathematical analysis results, and the designed coilgun system satisfy the target velocity with high energy efficiency. The stress of the coil structure was less than the allowable stress of the materials, and the increasing temperature was within the permissible range. The design specifications and the FEM analysis results of the coilgun for heavy projectile can effectively be utilized to develop a multi-stage induction type coilgun system.

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