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Design and Electromagnetic Analysis of an Induction Type Coilgun System with Pulse Power module

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Electromagnetic launchers with pulse power have an advantage over the chemical guns in that they has the ability to use electromagnetic force to accelerate armature to high velocity. A multi-stage induction type coilgun system is one of the most important research items. Especially, the capacitor driven induction coilgun, which is almost free from physical contact between the barrels and projectile, has a longer gun lifetime compared to other electromagnetic launchers. Accurate analysis of multi-stage induction coilgun is usually necessary to establish full-size finite element model. Full-size finite element model is suitable for accurate and detailed analysis, but it cannot solve the problem quickly because the analysis time increases with complex geometric structures. It is necessary to find a way to ensure both accuracy as well as rapid calculation.
In this paper we present design and electromagnetic analysis results of multi-stage induction type coilgun system with pulse power module obtained by using FEM program. The fundamental specifications of the induction type coilgun system were investigated via mathematical analysis model using MATLAB considering pulse power module. The voltage, current, force, velocity, acceleration, efficiency of the multi-stage coilgun system were analyzed using electromagnetic analysis. The electromagnetic analysis results were compared with mathematical analysis results to confirm the reliability of the FEM simulation model.
As a result, 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 has higher 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 can effectively be utilized to develop a large-scale multi-stage induction type coilgun system.

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