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Numerical Analysis of the Magnetic Expansion Force on the Solenoid Coil in a Four-stage Induction Coilgun with Pulsed Power Supplies

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The induction type multi-stage coilgun with pulsed power supplies has been widely developed to apply on the missile launcher system as cold-launching technology using electromagnetic forces. In this coilgun system, the electromagnetic energy generated by pulsed power module is transferd to the kinetic energy to accelerate the armature coil equipped with a projectile. It has advantages that the projectile is being contactless, flame-free launching process, and high reusability.

In general, in order to accelerate a heavy projectile to several tens of meters in height using an induction type coilgun, a high voltage pulsed power source which is about 1 kV to 10 kV is applied to the solenoidal exciting coil. Since the exciting coil is almost in a short circuit state, a large current flows instantaneously in the stator coil when a high-voltage pulsed power is applied. At this time, the magnetic expansion force is generated by the exciting current on the solenoid coil in radial direction of the stator coil.

This paper is focused on the mathematical calculation and numerical analysis of the magnetic expansion force acting on the solenoidal exciting coil induced by high-voltage pulsed power supplies. Above all, the analysis of the electromagnetic force on the stator coil is one of the essential basic design process to evaluate the structural stability and electromagnetic property for the launcher system. In this paper, the mathematical modeling of magnetic expansion force was proposed and the computed results from the proposed equation are verified through simulaed ones using finite element analysis.

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