

ULTIMATE KINEMATIC CHARACTERISTICS OF SINGLE-TURN COIL GUNS

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Abstract. Coil guns for accelerating conducting solids are a promising type of electromagnetic launchers. The absence of problems related to sliding metal contact, high efficiency, and high multi-shot performance make them a rather attractive tool for solving many both purely scientific and military problems.

The achievement of maximum acceleration velocities for accelerated bodies of specified mass with the preservation of the integrity of the inductor and accelerated body requires a detailed study and optimization of the accelerator performance. Such studies should be performed on the basis of a complete calculation of the magnetic field and current distributions in both the inductor and accelerated body to determine the resulting mechanical and thermal stresses and the accelerating forces.

It can be noted that despite the design simplicity, the system is described by a large number of parameters, including the geometrical dimensions and shape of the inductor and accelerated body, their electrothermal and mechanical properties, and the parameters of the electric circuit and the pulse power source.

The paper reports results of an investigation and optimization of single-turn coilgun performance aimed at attaining the maximum velocity at a specified accelerated mass and specified constraints on the maximum permissible mechanical and thermal loads.

Current distributions in conductors were calculated using the hybrid finite element boundary method modified to take into account the effect of the external circuit with constant inductance, resistance, and capacitance.

Results are presented on the acceleration of metal solids with masses of a few grams to several hundred grams to velocities of 0.2 km/sec – 3 km/sec with an efficiency of up to 40% for realistic parameters of the external circuit.