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5P35 - Design of a Pulsed Alternator to drive a Single Stage Induction Coilgun

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An induction coilgun launcher is being designed and developed in the author's laboratory to propel a solid aluminium projectile of 20 g. Pulsed alternators have several advantages over capacitor banks such as higher energy density, occurrence of natural current zero in the wave form and non-requirement of any external pulsed conditioning/ crowbarring circuit.
A single phase, iron core, slotted stator, cylindrical rotor, no-compensation topology of the pulsed alternator has been selected for this application. The maximum peripheral speed, the magnetic loading, i.e. flux densities in the stator and rotor iron parts and the electric loading, i.e. the temperature rise of the alternator windings as well as the coils of the coilgun have been selected as the main criterion for the study. The pulsed alternator has been modeled as armature, field and one damper circuit on each of the d and q axis magnetically coupled with each other. The damper circuits are modeled as per the transient eddy currents induced in the rotor teeth. The inductance and the resistance of the damper circuit are formulated by considering it as a winding with one turn per pole pair and having a cross sectional area equal to the width of the teeth multiplied by the skin depth of the induced currents.
A number of designs have been simulated and their performances have been analyzed for various design variables of the pulsed alternator. Projectile velocity, peak current and the temperature rise of the coil per shot (to understand the behavior under multi-shot operation) have been selected as the output variables. Similar analysis has also been done for different initial position of the projectile which gives some idea about the sensitivity of the multistage configuration.
On the basis of this analysis, final design of the pulsed alternator has been selected for the further work.

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