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5P38 - Utilization and Optimization of Superconducting Coil Parameters in Electromagnetic Launcher Systems

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Electromagnetic launchers are electrical machines which converts electrical energy to mechanical energy using pulse power supplies (PPS). Magnitude of currents are usually in the order of hundreds of kilo-amperes and their efficiencies are below 30%. High current generates heat which is one of the limiting factor of the whole system. Utilization of external coils placed on top and bottom of rails increases the Lorentz force on the armature which increases the efficiency. However, high B field limits the current capability of conventional copper wires. Superconductivity is achieved under the critical temperature of the materials which is usually below 10 K. However, with recent developments there exists high temperature superconductors (HTS) which can keep its superconducting properties in higher temperatures around 70K and only under DC currents. HTS wires have high current carrying capability around 100 $A/(mm)^2$ at self field at $77K$. B field and maximum current carrying capability of the HTS wire is inversely proportional. In order to maximize the electromagnetic force in the shot direction ,a real coded genetic algorithm (RCGA) is used. Optimization parameters are coil current, coil position, number of turns of the coil and number of layers of the coil. 2D finite element (FE) model is developed to calculate the objective function. The 2D FE model has 25mm x 25 mm square bore and the rails are 3 m long and has 1 MJ PPS. Moreover the developed optimization algorithm is repeated for different rail currents to observe the feasibility of the HTS with different energy levels for coil reinforced electromagnetic launcher system.

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