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Optimization of 1 T HTS main magnet for Extremity MRI using Real-Coded Genetic Algorithm

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The present study focuses on the optimal design of a 1 T main magnet operated at 65 K consisting of second-generation (2G) high-temperature superconductor (HTS) tape wound in the shape of double pancake (DP) coils for Extremity Magnetic Resonance Imaging (E-MRI) scanners by using the population-based real-coded genetic algorithm (RGA). In the RGA, the minimum length of HTS tape consumption is used as a fitness function for a given central field of 1T with a field homogeneity of less than 20 ppm inside a diameter of spherical volume (DSV) of 80 mm. The simulated binary crossover (SBX) and polynomial mutation functions are considered for creating the modified solutions in each iteration, and elitism is used for faster convergence to the optimal solution. The above algorithm is implemented by using a finite element method (FEM) package (i.e., COMSOL Multiphysics) along with MATLAB Live-Link. The FEM package is used to calculate all the parameters related to the HTS magnet, i.e., maximum perpendicular field (B_⊥), central magnetic field, field homogeneity, stresses, and 5 gauss-stray field, while the selection, crossover, and mutation operations are evaluated in MATLAB. The minimum length of HTS tape consumption for two cases: non-insulated (NI) and Kapton-insulated DP coil-based magnets, is compared.

Submitters Country

India

Author: Mr CHAND, SUMIT KUMAR (Research Scholar)

Co-authors: Mr ANAND, ANKIT (Research Scholar); Dr GOUR, ABHAY SINGH (Assistant Professor); Dr DATTA, TRIPTI SEKHAR (Visiting Professor)

Presenter: Mr CHAND, SUMIT KUMAR (Research Scholar)

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