Optimal Design of an Inductor for MFH: From Models to Measurements

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Abstract

Magnetic fluid hyperthermia is a cancer therapy that uses magnetic fluid to heat locally cancer cells [1]. In fact, a magnetic nanoparticle fluid heats when a time varying magnetic field at few hundred of kHz is applied [2]. In order to assess the heating capability of the magnetic fluid in biological systems, the nanoparticle fluids must be subject to a highly homogeneous magnetic field of prescribed value. In the paper the optimal design of the inductor used to heat a magnetic nanoparticle fluid injected in a cell culture inside a Petri dish is presented [3]. The inductor design is driven by means of an innovative multi-objective optimization algorithm based on Migration-NSGA algorithm [4]. The geometry has two-turn inductor, exhibiting internal radius of 85 mm equipped with ferrite blocks in order to control the distribution of magnetic flux lines in the Petri dish bottom. The field analysis problem is solved in time-harmonics conditions using the Finite Element method. The optimization problem aims at minimizing the inhomogeneity of the magnetic field (f1) in the Petri dish bottom, computed using the "proximity criterion" [3], and simultaneously maximizing the magnetic field strength (f2) in the Petri dish bottom. In the proposed MNSGA algorithm the updating of the design variables is managed by means of a Self-Adapting (SA) algorithm, that exploits the periodic insertion of a 'migrating' population in order to vary the genetic heritage of the whole population. Finally, SA-MNSGA convergence criterion is based on a 'no longer improved' criterion that evaluates the utopia point displacement and improvement of approximated Pareto front. Finally, considering the proposed geometry, magnetic field measurements will be performed in order to experimentally evaluate the field homogeneity.

References

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