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A comparison between ABC method and PSO method for Hysteresis Parameter determination

D. Sedira^{a,*}, Y.Gabi^b, A. Kedous-Lebouc^c, K. Jacob^b, B. Wolter^b and B. Straß^b

^aLaboratoire d'étude et de modélisation en électrotechnique, Faculté des sciences et de la technologie, Université Mohamed Seddik Ben Yahia, BP98, Jijel 18000, Algeria

^bFraunhofer Institute for Nondestructive Testing IZFP, Campus E3, 66123 Saarebruecken, Germany

^cUniv. Grenoble Alpes, CNRS, Grenoble INP, G2Elab, F-38000 Grenoble, France 21 avenue des Martyrs CS 90624, Grenoble 38031, France

Accurate analysis and optimal operation of electromagnetic devices can only be predicted by a robust modeling of ferromagnetic materials. In this context, several hysteresis models have been proposed. The Jiles-Atherton model [1] is commonly used, it is among the main studied in the literature. However, it requires robust identification process of five interdependent parameters, based on experimental hysteresis loop. In a recent paper, the artificial bee colony ABC method, inspired by the collective behavior of bees [2] is applied for the identification [3]. The present work deals about comparison between the ABC method and the particle swarm optimization method PSO [4], which is based on the motion of swarms of birds and fishes. The objective of this study is to give performance of both algorithms in computing time, iteration numbers and parameter estimation. Finally, obtained hysteresis loops is compared to experiment data.

Keywords: ABC method, PSO method, Jiles-Atherton model.

1. Jiles-Atherton model

In Jiles-Atherton model the differential equation for the rate of change of the total magnetization is given by:

$$\frac{dM}{dH} = (1-c) \frac{M_{an} - M_{irr}}{k\delta - \alpha(M_{an} - M_{irr})} + c \frac{dM_{an}}{dH} \quad (1)$$

The anhysteretic magnetization M_{an} follows the Langevin function and depends on two parameters; M_s the saturation magnetization and a a normalization constant; M_{irr} represents the irreversible magnetization. The application of this model needs a parameter process identification of α that takes account for interdomain coupling; c that accounts for reversible motion; k a coefficient accounting for the pinning energy; M_s and a .

2. ABC method

The machine-learning algorithm proposed by Karaboga [2] is based on the bees behavior during the nectar collection. The bees are divided in three groups: employed bees, onlookers bees and the scouts bees. The employed bees search for the source food position which represent the solution for a given problem and exchange the obtained information with the onlooker bees. These ones select a new source food position and exploit them. When a food source is abandoned the scout bees search for a new source food position. The optimization problem consists on finding the best parameters which minimizes an objective function.

3. PSO method

The particle swarm optimization (PSO) is introduced by Kennedy and Eberhart [4] in 1995. The method is based on the definition of a search space consisting of a certain number of particles and a function to be optimized. Each particle is characterized by its current position, its speed and its best position. During the optimization operation, each particle moved to find the optimum.

4. Methodology

The two identification methods mentioned above are applied to have the best set of J-A parameters, for the both a fitness function is evaluated using the measured magnetization hysteresis loop and modelled magnetization using the optimized solution.

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* Corresponding author: d.sedira@gmail.com