BPM Motor Loss Minimization with Constraints In Perspective of Life Cycle Assessment.

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The "off the shelf" (commercially available) brushless permanent magnet motor is evaluated for electromagnetic loss minimization in order to increase motor efficiency. The proposed analysis is conducted with the perspective of satisfying a global thinking approach to the evaluation with "Life Cycle Assessment". This will be done in an attempt to reduce the power consumption impact of the brushless permanent magnet motor in its industrial application.

The key electromagnetic loss components are the stator winding resistive losses, the motor magnetic material iron core losses and the rotor magnet eddy current losses. These electromagnetic losses are provided through a finite element dynamic computation that simulates the motor's real-life operations. As such the power budget can be visualized to depict the impact of different loss components and can be used to develop a targeted loss reduction strategy.

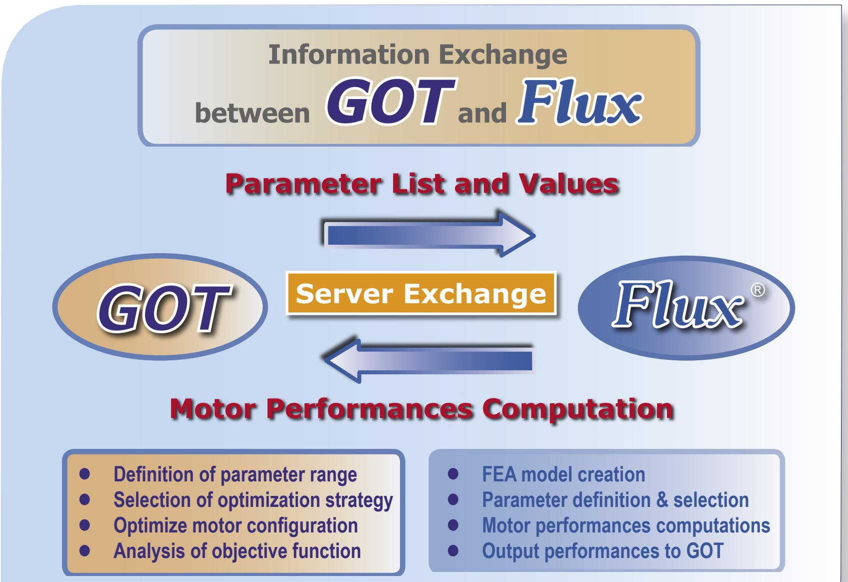
The motor geometry features such as the rotor magnet shape and the stator lamination details (i.e. slot opening, tooth width) along with the motor's physical properties (i. e. motor current, materials) are considered as possible design parameters for the optimization process to minimize the electromagnetic losses.

Two optimization strategies and algorithms are considered for comparison. The first strategy is engineering oriented and requires a level of motor design expertise for effective execution. It consists of performing an initial Screening to extract the most influential parameters. Then a transformation is performed, utilizing a smaller number of key design parameters, into a 2-step optimization process. This approach entails laying the ground work with concise preparation by reducing the number of parameters within the optimization domain. The result is that the evaluation of the objective functions and constraints becomes more economical.

The second strategy is Stochastic based on the use of a Genetic Algorithm to automatically find the minimum of electromagnetic losses for the motor for all of the given design parameters. This approach results in a more robust, computationally intensive process requiring more finite elements solutions

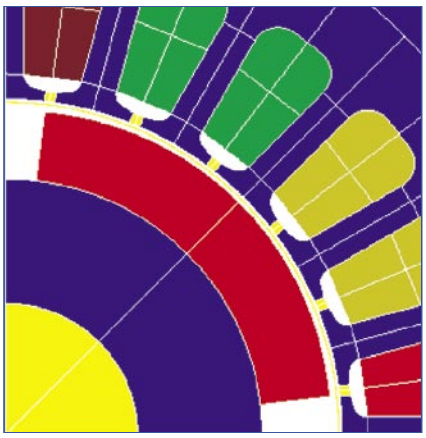
During the design optimization procedure, there are trade-offs in terms of quantity of materials and the type of (regular or advanced) materials employed. These factors effectively illustrate the importance of "Life Cycle Assessment" to evaluate the environment cost.

Utilization of this sort of optimization procedure will result in an impact to both the initial financial cost along with a reduction in the operating cost, affording insight to the true impact of the design optimization over the motor life rather just its electromagnetic performances.

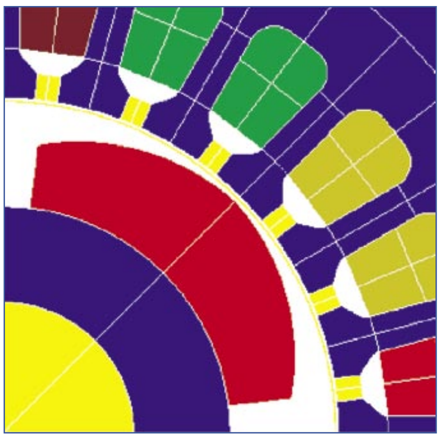


GOT stands for General Optimisation Tool. Developped by J. L. Coulomb in G2ELab, it has been used in the research community for years. CEDRAT will industrialize and market this product in 2011.

	Name	Initial	Optimum 1	Optimum 2
Motor Phase Current (Amps rms)	A_IRMS	30.00	15.40	21
Magnet Br	A_Br	0.41	0.8	0.69
Slot Opening in mm	A_SO	0.90	0.82	1.75
Stator Tooth Angle in deg.	A_SOAng	20.00	10.00	39.9
Tooth Tip Thickness in mm	A_TGD	1.00	0.80	2.00
Magnet Thickness in mm	A_LM	5.50	5.56	7.73
Magnet Arc Angle in deg.	A_BetaM	150.00	152.80	152.2
Magnet Edge Height in mm	A_Edge	5.50	5.30	4.86
Motor Losses in Watts	$Losses_{motor}$	413.42	130.67	217.31
Average Torque in N.m	T_Ave	2.51	2.50	2.5
Torque Ripples in %	T_Ripples	5.56	4.21	3.01



Optimum geometry - Process 1.



Optimum geometry - Process 2.