APPLICATION OF SOFT MAGNETIC MATERIALS IN DEVELOPMENT OF NEW EXPERIMENTAL MODEL OF SINGLE PHASE SHADED POLE MOTOR

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Abstract – In this paper is presented development of new experimental model of single phase shaded pole motor using soft magnetic materials. At the beginning, using analytic approach with symmetrical components a mathematical model of the basic model is developed. Accuracy of the model is verified by an experiment. Afterwards, using Method of Genetic algorithm (GA) and introducing as a target function electromagnetic torque, new optimized motor model with improved electromagnetic torque is derived. Further on by application of soft magnetic materials in optimized motor model a new experimental motor model is derived with decreased losses and improved efficiency. Comparative analysis of all motor models using Finite Element Method (FEM) is performed.

Shaded Pole Motor Optimization by Method of Genetic Algorithms

Method of Genetic Algorithm as a powerful optimization tool is applied to a single phase shaded pole motor, type AKO-16, product of “Mikron” adopted in this investigation as basic model-BM. Rated data of the motor, known by the producer are: U_n=220 V; f_n=50 Hz; I_{1n}=0.125 A; P_{1n}=18 W; n_n=2520 rpm; 2p=2. The number of turns of the main stator winding is 1744/per pole.

The improved motor model, while varying motor input parameters as current density Δ [A/mm^2], magnetic flux density B [T], number of turns W and angle of rotor skewing α_{sk}, is derived- model 1 (M1) [1].

In new motor model is achieved a significant increase of electro-magnetic torque M_{em} and of the efficiency factor η. Only a brief comparison of motor model characteristics is presented in Table I.

TABLE I COMPARISON OF MOTOR CHARACTERISTICS

Quantity	Basic model	Model 1
Main winding turns per pole *W*	1744	1566
Stator current I_1 [A]	0.126	0.168
Short circuit coil current I_3 [A]	0.0063	0.0083
Rotor current I_2 [A]	0.0878	0.1176
Input power P_1 [W]	18.11	21.667
Output power P_2 [W]	4.149	6.1775
Efficiency factor η [/]	0.229	0.285
Electromagnetic torque M_{em} [mNm]	18.075	25.76

The result of GA optimization is lower current density in the main stator winding in new derived model of the motor. This fact leads to greater diameter of winding wire, resulting in lower resistance of the stator and rotor windings; finally, currents, and consequently the static torque, as well as the output power, are increased.

After the optimization procedure is completed, the results are presented on diagrams. For better understanding the behavior of all shaded pole motor models, comparative performance characteristics of electromagnetic torque M_{em}=f(s), efficiency factor η=f(s) are presented in Figures 1 and 2.

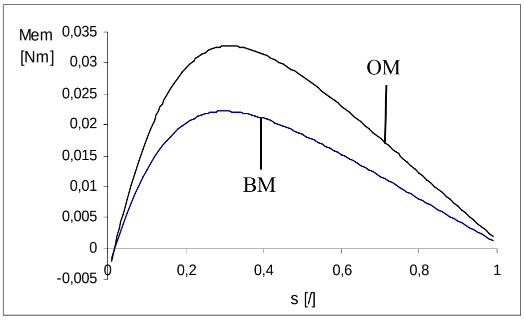


Fig.1 Comparative characteristics $M_{em}=f(s)$

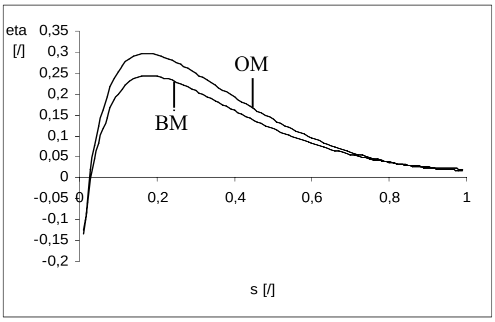
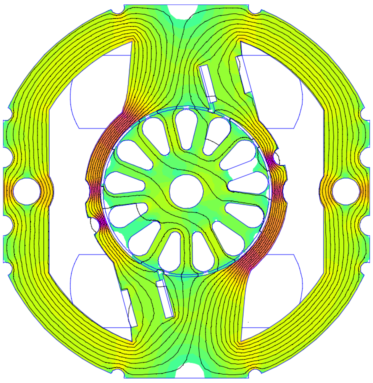


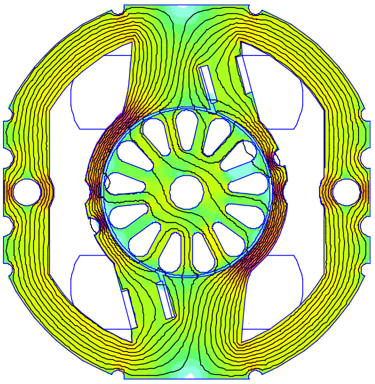
Fig.2 Comparative characteristics $\eta=f(s)$

Comparative FEM Analysis of Derived Motor Models

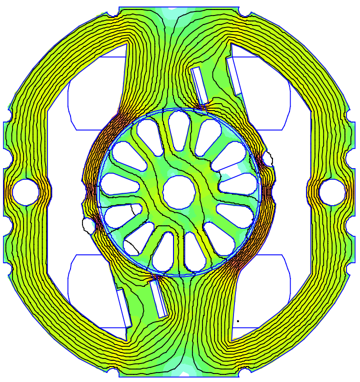
Usage of conventional magnet materials in construction of electrical machines is always followed by cutting of magnetic material into desired shape and consequently there is always a considerable amount of waste material which enlarges the machine production costs. Therefore there is a worldwide intention of founding new alternative technologies and materials. Composite magnet materials which are used in construction of electrical machines are known as soft magnetic materials. They can be easily shaped into desired form and enable modular construction of stator and/or rotor of the electrical machine. Soft magnetic material Somaly™500 is used for the construction of new experimental model – EM. EM is derived from optimized model by putting the soft magnetic material in the stator notch where the short circuit coil is placed. Comparative analysis of BM, OM and EM is performed by using contemporary numerical method – FEM for analysis of electromagnetic phenomena inside the machine. Obtained results from comparison of electromagnetic field for rated load condition $s_n=0.16$ are presented in Figure 3.



a) BM $A_{max}=0,0050498$ [Vs/m]



b) OM $A_{max}=0,00563$ [Vs/m]



c) EM $A_{max}=0,00602$ [Vs/m]

Fig. 3 FEM comparative analysis

New experimental model shows lower copper losses and considerable decreasing of total losses compared with optimized model. In full paper version a more detailed analysis will be carried out regarding performances and improvements of the experimental model.

References

[1] V. Sarac, L. Petkovska, M. Cundev, "An Improved Performance Analysis of a Shaded Pole Motor", *Proceedings of PCIM'01 Conference*, Vol. 2 – Intelligent Motion, p.p. 399-404, 2001.

[2] V. Sarac, L. Petkovska, G. Cvetkovski, "Potential of Soft Magnetic Powders for Shaded Pole Motor Design", *Book of Abstracts of the 11th International Symposium on Numerical Field Calculation in Electrical Engineering – IGTE'2004,* p.p. 58, full manuscript published on **CD** pp.1-6, 2004.