Performance Evaluation of an Axial Flux Claw Pole Machine with Soft Magnetic Composite Cores

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Background

Soft magnetic composite (SMC) material is a new kind of soft magnetic material, it has been used for designing the electromagnetic device which including the electrical machine and inductor now. To enlarge the advantages of the SMC material, this paper propose a new axial flux claw pole machine (AFCPM), for the actual application, the AFCPM can output good performance, since it can combine the concept of the claw pole machine and the axial flux machine. Moreover the two phase AFCPM is investigated to cancel the unbalanced axial force.

Objectives

- New AFCPM can output better performance than the traditional TFM in terms of the torque density, efficiency, and etc..
- The best topology of the two phase AFCPM are obtained based on the comparative study of four kinds of configurations.

Conclusion

- New topology of the AFCPM is proposed and introduced, its working principle is discussed.
- Compared with TFM, the AFCPM can have better power density, torque/cost and high efficiency.
- To cancel the unbalanced axial force, four kinds of two phase AFCPM are proposed and their difference is discussed.
- Based on the finite element method, the no load magnetic field distribution, the unbalanced axial force , cogging torque, PM flux linkage, inductance of above machines are calculated, compared and presented. The unbalanced axial force of the AFCPM with SRS is much lower, and the mutual inductance of the AFCPM with two single disk is almost zero.
- In terms of performance, the torque density of AFCPM with the configuration of RSRs is the highest one and the torque/cost of the AFCPM with the configuration of SRS is the highest one.

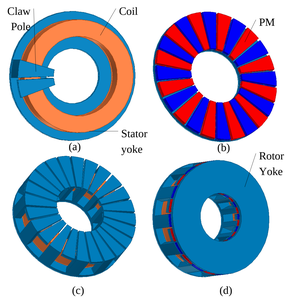
One disk AFCPM

One disk AFCPM

The one disk AFCPM is consist of the stator core, global winding and the rotor.

The magnets in the rotor are magnetized in the axial direction and the adjacent magnets are magnetized in the opposite directions

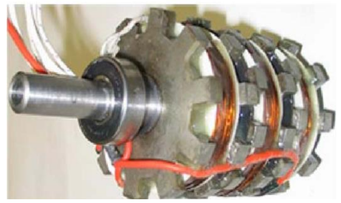
The stator core has the claw pole and the stator back iron, it is made by the SMC material.



Comparison of the AFCPM and TFM

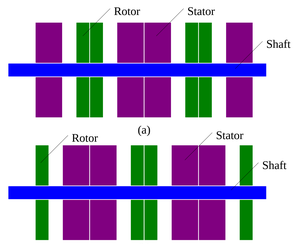
Item	AFCPM	TFM
Power (W)	882	631
Torque (Nm)	4.68	3.35
Torque per unit weight(Nm/kg)	2.12	1.41
Torque per unit cost (Nm/AUD)	0.156	0.089
efficiency	0.81	0.79

Stator of the TFM



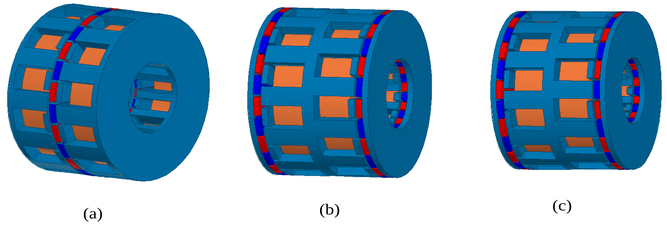
Two phase AFCPM

Normal double side Axial flux machine



Two phase AFCPM

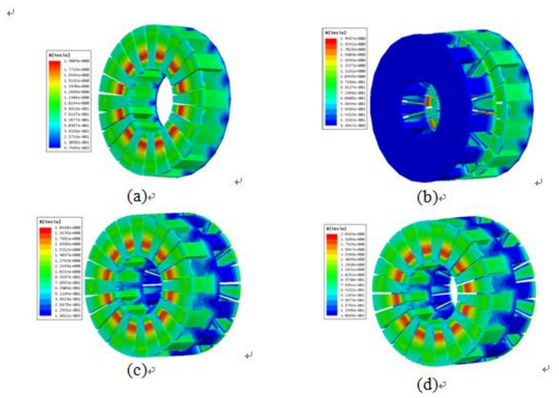
In this paper, four kinds of different AFCPM is proposed, including the two phase AFCPM based on two single disk AFCPM (SR), two phase AFCPM with one stator core in between of two single rotors (RSR), and two phase AFCPM with the rotor in between of two stator cores (SRS)



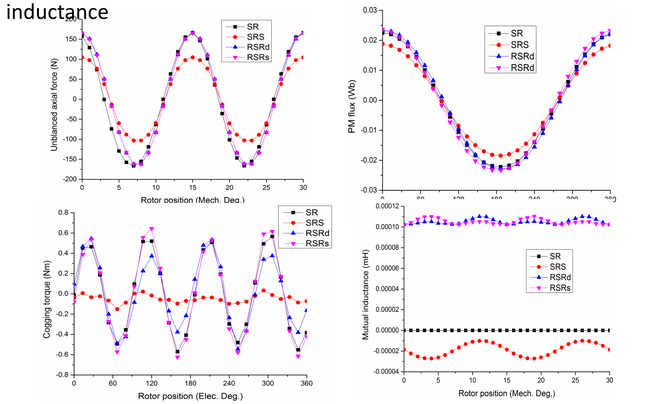
Results

Comparison of them based on the FEM

No load magnetic field distribution

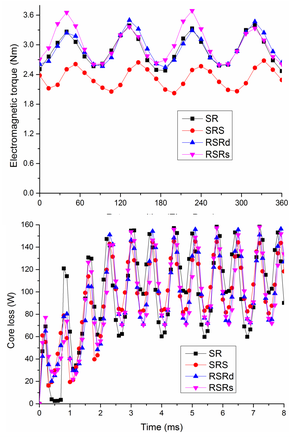


Unbalanced force, cogging torque, PM flux linkage, and mutual inductance



Performance comparison

Torque and loss



COMPARISON PERFORMANCE

Item	AFCPM (SR)	AFCPM (SRS)	AFCPM (RSRd)	AFCPM (RSRs)	TFM
Power (W)	688	533	701	710	631
Torque (Nm)	3.12	2.42	3.18	3.22	3.35
Torque per unit weight(Nm/kg)	2.12	1.70	2.16	2.18	1.41
Torque per unit cost (Nm/AUD)	0.156	0.196	0.159	0.161	0.089
efficiency	0.81	0.73	0.82	0.83	0.79