The Properties Comparisons of AAM and Silicon Steel

- Amorphous alloy material (AAM) has low iron loss benefitting from its low coercivity and high resistance.
- The saturation flux density of AAM is about 1.5 T which is lower than that of the traditional silicon steel.
- The Vickers hardness of AAM is higher than 900HV and that of traditional silicon steel is usually lower than 200HV.
- The AAM ribbon is very hard and brittle, which makes AAM difficult to process using the traditional stamping technology.

Fig. 1. Iron loss curve of amorphous alloy material and silicon steel.

Fig. 2. BH curve of amorphous alloy material and silicon steel.

The Topology and Application Backgrounding of OR-PMSMASC

Fig. 3 illustrates the structure of the outer-rotor permanent magnet synchronous machine with amorphous stator core (OR-PMSMASC). The outer-rotor structure is selected for improving the loading capacity and the condition of heat dissipation. Considering the most iron loss is distributed in the stator core and the low saturation flux density of AAM, the stator core is only selected to be manufactured by AAM. The stator core is stacked by the thin amorphous alloy material laminations, and the outer-rotor is manufactured by the solid electrical steel with arc-shaped rare-earth PMs pasted in its interior surface.

Fig. 4. Load torque profile of the propeller.

Fig. 5. Normalized load cycle of the PPUAV in one flight.

Conclusion

In this paper, the OR-PMSMASC is designed which is applied to the PPUAV. The load cycle of the PPUAV is studied and an optimal procedure based on the load cycle is launched. The efficiency and energy consumed in a load cycle of the initial and optimal designs are investigated and compared based on the 2-D FEA. An optimal procedure aims at a low cost high efficiency design based on the load cycle is presented. A prototype of OR-PMSMASC based on the optimal design 2 is manufactured and tested. The PPUAV can reach a larger range of one flight equipped with the same capacity of battery after the optimal procedure. The optimal procedure based on the load cycle can provide a better tradeoff between the performance and cost. Comparison with the optimal design based on the rated power point, the optimal design based on the load cycle consumes the same energy with much lower material cost. The cost reduction can be a considerable number in the volume production process.