A Novel Design Method for the Electrical Machines with Biased DC Excitation Flux Linkage

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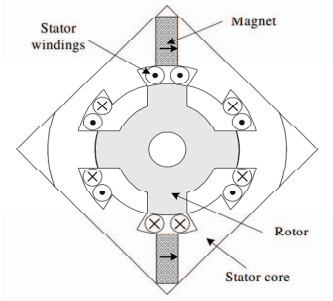
Electrical Machines are the devices which produce torque by the interaction of the stator and rotor flux linkages. To obtain the maximum torque, the winding current is usually controlled according to the waveforms of back-EMF. However, few papers study about how to design the stator winding and control the winding current according to the excitation flux linkage waveforms. If we focus on the excitation flux forms, the machines can be divided into two categories. 1) The machines without biased DC excitation flux, such as the BLDCMs, PMSMs and the flux switched permanent machines (FSPMs). 2) The machines with biased DC excitation flux, such as the double salient permanent machines (DSPMs) and most of the electrical excitation and hybrid excitation machines.

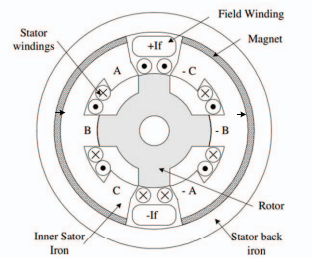
This paper points out a new view, the stator windings can be redesigned and winding current can be controlled according to the excitation flux linkage, and it would be beneficial for the second type machines to realize higher power density and wider constant power speed range.

Fig.1 shows three types of machines with biased DC excitation flux linkage, namely the classi[1], hybrid excitation[2] and electrical excitation[3] double salient machines, which are taken as examples to demonstrate the working principle and advantages of this design and control method. The key is to inject additional biased DC current to modulate the excitation flux. To realize this, the coils in each winding should be divided in two groups, the original Y structure windings reconnected as double Y layers structure. By applying this idea, the structures in Fig.1(a) and Fig.1(b) can be unified as the one in Fig.2(a). Where the biased DC current between double layers can replace the DC field windings to adjust the excitation flux. The electrical excitation machine in Fig.1(c) can be redesigned as the one in Fig.2(b), where the DC windings is removed since the biased DC current can produce the excitation flux.

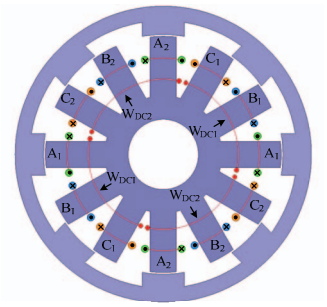
This method is beneficial to simplify the control system, reduce the machine volume and cost, strengthen the flux modulating ability.



(a) 6/4 double salient machine

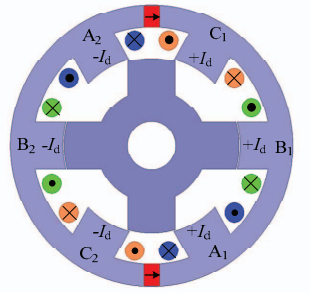


(b) 6/4 hybrid excitation double salient machine

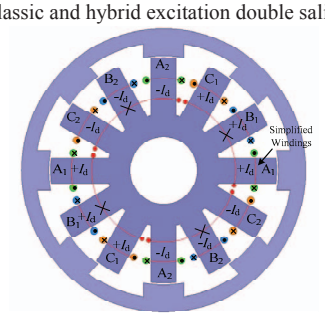


(c) Electrical excitation double salient machine

Fig. 1 three types of machines with biased DC excitation flux linkage



(a) Unified classic and hybrid excitation double salient machines



(b) Resigned electrical excitation double salient machines

Fig. 2 Application examples of the proposed novel design method

References

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