Axial Flux Induction Motor

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ABSTRACT:* Hybrid and electric vehicles are the main target of many academic and industrial studies to scale back transport pollution; they're now established products. In hybrid and electric vehicles, the drive motor should have high torque density, high power density, high efficiency, strong physical structure and variable speed range. An axial flux induction motor is a stimulating solution, where the motor may be a double sided axial flux machine. This will significantly increase torque density. During this paper a review of the axial flux motor for automotive applications, and therefore the different possible topologies for the axial field motor, are presented.

KEYWORDS: Axial Flux Induction Motor, Hybrid and Electric Vehicles, Radial Flux Machine.

INTRODUCTION

Automotive vehicles are obviously a standard means of transport. The pollution caused by combustion motors reduced air quality, increase the contamination carbon dioxide within the environment, especially in large cities where the concentration of vehicles are often vital. An alternative sustainable solution for transportation is therefore needed to scale back emissions. Plug-in hybrid and electric vehicles are the main target of the many researchers and automotive companies within the world to unravel this problem. These are now commercially available. It should change state in mind that the electrical energy utilized in these vehicles should be sourced from renewable energy sources for these vehicles to be classed as “green”. Within the design of the electrical vehicles, energy and power density of energy storage and conversion units are important, and indirectly associated with the dimensions and weight of the vehicle. The electrical motor utilized in an electrical vehicle are often DC or AC and therefore the controller of the motor is associated to the motor type. These got to be very torque dense and operate over a good speed range.

An induction motor or offbeat motor is an AC electric motor where the electric flow in the rotor expected to deliver force is gotten by electromagnetic asynchronous from the attractive field of the stator winding. An induction motor can in this manner be made without electrical associations with the rotor. An induction motor's rotor can be either wound sort or squirrel-cage type.

Three-stage squirrel-cage asynchronous motors are broadly utilized as modern drives since they are self-beginning, solid and affordable. Single-stage induction motors are utilized widely for more modest burdens, for example, family unit apparatuses like fans. Albeit customarily utilized in fixed-speed administration, asynchronous motors are progressively being utilized with variable-recurrence drives (VFD) in factor speed administration. VFDs offer particularly significant energy reserve funds openings for existing and forthcoming induction motors in factor force divergent fan, siphon and blower load applications. Squirrel-cage asynchronous motors are generally utilized in both fixed-speed and variable-recurrence drive applications.

Figure 1: Axial Flux Induction Motor[1]

The axial flux induction motor (AFIM) has disc type design consisting of axial air gap (figure 1). Compared to the traditional radial flux motors where the conductors are arranged axially, in case of axial flux motor the electrical circuit- stator conductors and rotor bars are arranged radially because of topological changes. The working rule of axial flux induction motors is same as that of conventional radial flux induction motors. When the main axial flux cuts the rotor bars, force applies on rotor bars and due to Lenz's it moves in a direction which minimizes the rotor induced EMF. The electromagnetic torque in AFIM is produced over a continuum of radii, not just at a constant radius as in conventional motors, because the size of electric and magnetic circuits of AFIM motor are function of the radius. Nowadays, the AFIMs are being widely utilized in applications like electric vehicle (EV), hybrid electric vehicle (EHV), permanent magnet synchronous generator (PMSG) and static magnet induction generator (PMIG) due to its advantages of better power-to-weight ratio, power–to-diameter ratio, power-to-length ratio, efficiency etc. These machines exhibit higher use of active material and better cooling. Pan cake type flat shape and compact construction of those motors facilitates small power domestic applications for electrical vehicle, pumps, fans, food processors etc.[2]. AFIM is additionally preferred in applications, where rotor are often integrated with the rotating a part of mechanical loads. The history reveals that the earliest axial flux machines were using permanent magnetic materials. However, due to poor quality of hard magnetic materials which were utilized in earlier machines the event of AFM was discouraged. Thanks to this, the traditional sort of machines got popularity for several decades. Due to active researches within the field of fabric science and metallurgy, low cost powerful permanent magnets are now commercially available. the supply of Alnico, Barium Ferrite and especially the rare-earth neodymium-iron-boron (NdFeB) permanent magnets, the event of Axial flux PM machine increased many fold This has also simultaneously encouraged the event of AFIM and other sorts of electrical motors and generators[3].

Based on the flux direction within the air gap, electromechanical energy conversion machines are classified into Radial Flux Machines and Axial Flux Machines[4]. The working rule involved in both the axial flux and radial flux machine are same but differs in its construction. In conventional radial flux machines the conductors are placed in parallel and therefore the direction of air gap flux is radial to the shaft axis whereas within the axial flux machines the conductors are placed in radial to the shaft and air gap flux is parallel to the shaft[5]. The earliest machines were AFMs though they were replaced by RFM after a comparatively short period of your time. In 1821, Faraday invented a primitive disc motor which was within the sort of an AFM. However, since 1837, when Davenport claimed the primary patent for a RFM, it became the accepted configuration for electrical machines. Since 1980 the applicability of axial flux machines to low-speed, direct-drive electrical drive applications has been studied[6].

Limitations of Radial flux machines:

1. Bottle – Neck for the flux path at the basis of the rotor slot.
2. Cooling Problem.

3. Inefficient utilization of Rotor Core.
4. Long motor length is required because the torque is produced at a hard and fast air-gap diameter which is effectively smaller than the axial field motor where torque producing diameter grows radially for a hard and fast air-gap length.

These Limitations can't be conveniently employed unless there's an alteration within the geometry of the RF machine which results in an AF machine.

Advantages of Axial flux machines:

1. Cooling is improved
2. Large axial length isn't required for the assembly of high torque.
3. Tooth flux is constant.
4. Efficient utilization of rotor core
5. At a time it are often operated at different speeds with multi air gap topology.

In axial flux machines the stator has ring structure and rotor is disc shaped. The radial length from the stator inner radius to the outer radius is that the active part to supply the torque and therefore the axial length depends on the right yoke design of the stator and therefore the rotor i.e., the flux within the stator and rotor yokes[3]. Though the amount of poles increases the active radial a part of the machine remains unchanged and therefore the axial length depends on the flux in stator and rotor yokes. When the ratio of motor overall length to motor external diameter > 1 then radial flux type is preferred and when its < 0.3 axial flux type machine is preferred. Thus the axial flux machine has the pliability in having higher pole number which let the machine to be a beautiful alternative for the low speed applications. Furthermore it's high efficiency, high power and torque densities and low rotor losses[7].

LITERATURE REVIEW

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Plug-in hybrid and electric vehicles are the main target of the many researchers and automotive companies within the world to unravel this problem. These are now commercially available. It should change state in mind that the electrical energy utilized in these vehicles should be sourced from renewable energy sources for these vehicles to be classed as “green”[7]**.**

CONCLUSION

In this paper a review of the axial-flux motors is presented within the context of an automotive drive. The axial flux induction motor has been chosen because the motor to be utilized in this work since it's the potential to be a compact and price effective machine. A quick comparison between the axial fluxes motors and radial flux motors was presented. The paper also presented equations describing the induction motor circuit for power and torque characteristics. Further work are going to be on the simulation and analysis of the consequences of the various parameters on the performance characteristics of axial flux induction motor for automotive applications.

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