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Multiple Electric Motors used in Electric Vehicles

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ABSTRACT

Demand for green energy and the desire to reduce CO2 emissions from combustion engines have brought together researchers and engineers from rectifiers to explore and develop new drive systems. Automotive emissions have been significantly cut in the case of hybrid cars. However, this is still not enough. The vehicle unit's solely electric field is 100 percent protected and its planning is of significant importance. As a result, these engines substitute electric motors for the internal combustion engines in ordinary vehicles and vehicles. Therefore, for researchers in the field, the need for highly improved engines that can work optimally is of interest. This paper provides a analysis of the different electrical motors with their size, size, strength and performance nature, as well as a technical overview of the power density, performance, reliability and cost factor. Finally, with regard to the propulsion of electric cars and hybrid electric vehicles, the brushless DC motor is intended to be an inexpensive and ideally suitable alternative.

Keywords *- Electric motors, EVs, Theoretical Analysis*

I. INTRODUCTION

Following a growing outrage from environmental groups and government officials, it is imperative that due to their effect on the layer, carbon pollution must be required to be significantly diminished. Combustion engines (ICEs) are powered by normal quality equipment (vehicles) and so burn coal and gas to CO2, so that the environment is impacted. Although the research centered on energy land, it contributed to the incidence and creation of hybrid electric vehicles victimizing each internal combustion engines (ICE) and electric motor to power their wheels, since then, electric cars alone have been on the road and are in service.[3]. For propulsion, these vehicles use one or more electric motors. Researchers are currently studying diverse energy sources for property efficiency, ranging from solar, wind, wave, to novice oil-powered vehicles.

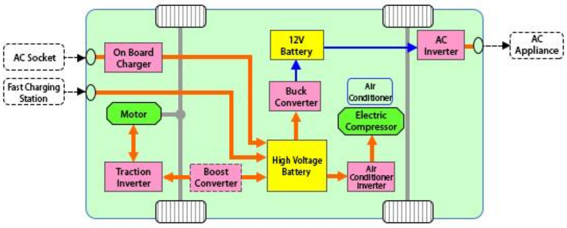

Fig. 1 Diagram of electric vehicle

The electric motor consists of three main structures: the unit for energy recovery, the auxiliary system and the control propulsion systems. The electronic propulsion system consists of an Associate in Caring electronic controller, an impact amplifier, a mechanical transmission and an electric motor. This article discusses an study of the different motors used for the propulsion of electric vehicles. The electrical device diagram is seen in Figure 1. The evolution of electrical drives dates back to the eighteenth century, when Michael Faraday demonstrated the speculation of the induction of magnetic power. Following the invention of Faraday's law, electrical motors were invented and two major types of engines, electrical energy and also electrical motors were produced.

II. VARIOUS TYPES OF ELECTRIC MOTOR DRIVES

Motor drives for electrical vehicles should not be compared to equivalent drives for industrial processes, because in a variety of settings electric moving vehicles must undergo daily start / stop cycles, while in industrial processes the motors usually run at controlled speeds. The engine drive is a most important part of the operation for every EV propulsion unit, including the electric motor, the converter and the electronic control. [1]. The motor drive used should be able to meet certain requirements in the case of EVs which allow it to operate effectively as part of the propulsion system. Both capabilities are high instant capacity and high power density. And, because the vehicle should be able to run on any surface, a high torque is required while the engine is at a low speed both at start and during the ascent.

Manufacturers use entirely separate electrical motors as part of the drive mechanism for the manufacture of electric cars. A number of versions of EVs by entirely separate companies square measure mentioned below, in accordance with the kind of engine used in Table 1. The Honda EV uses a magnet brushless motor and uses nickel-metal-hydride (NiMH) batteries for some of the technical features of a number of the electric vehicle models. It has a top speed of eighty mph and can travel 80-100 miles at an incredibly high rate. The EVI metric weight device sold by general-purpose engines uses an associated induction motor which can achieve a range of 55-95 miles in excess of charge until the lead acid battery has been used which 75-130 for NiMH batteries. Many more or fewer electrical vehicles have the same speed and variety. One thing that prohibits the development of these cars is the thing of valuation. Conjointly modern advances in battery technology have been produced to make them additionally desirable and jointly economically viable [4].

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Table 1: Different models of electric vehicles.

Company	Model	Motor
Fiat	Fiat Panda Electra	Series dc motor
Fiat	Fiat Seicento Elettra	Induction motor
Honda	Honda EV Plus	PM brushless motor
Mazda	Mazda Bongo	Shunt dc motor
Nissan	Nissan Altra	PM brushless motor
Toyota	Toyota RAV 4	PM brushless motor
General Motors	GM EVI	Induction motor

The electric motor is normally rotor, stator, winding , an air gap and converter. In view of the entirely different arrangement of these parts, different electric motor types are made. Brushless static magnet motors are called electric motors and do not require switching pins or transferring energy. What's more, the engines can be graded in accordance with the shape of their backs-EMF. Its shape is either curved or quadrangular. These shapes are assisted by static magnet AC Synchronous Motors or BLDC motor many times.

To successfully deploy the electric motor and to run EVs extremely cost-effectively, it should have a land density and be solid. However, the performance of the engines depends on the purpose of its use. This application may vary from home, routine transport and big duty vehicles. What is more, the efficiency of the engines depends, in the main, on the vehicle mission cycle, on the thermal characteristics and hence the cooling mechanism applied. Figure 2 shows the overview of the different motors used for traction. Following is a concise overview of the literature on traction motors used in EV / HEVs.

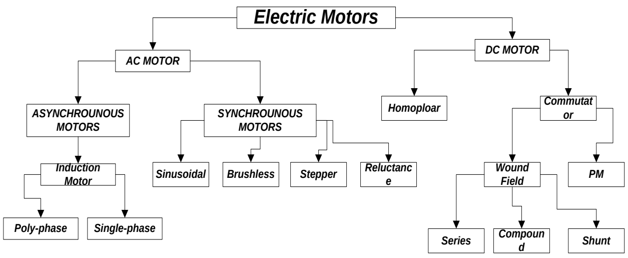

Fig 2 - Classes of Electric Motors

III. THE ALTERNATING CURRENT (A.C) MOTORS

This segment reviews electrical motors with sinusoidal power. It is further separated into synchronous and asynchronous motors.

A. Synchronous Motors

Synchronous motors are engines that match the rotor 's shaft with the supply current frequency. The rotor cycle is exactly the same as that of these motors.

I. Permanent Magnet Synchronous Motor (PMSM)

This motor shares some parallels with the BLDC motor, but a curving signal powers the lower torsion leg. The curving distribution of the MPSW creates a curve density within the air vacuum which is entirely different from the tetragon density of the BLDC generator [2]. This engine has the related role in the parenting induction engine and the brushless DC engine. The engine is used with a magnet rotor and winding on its stator bow. Moreover, the stator coil of this motor is intended to provide curving density that parallels that of Associate in nursing induction motor. These motors are currently designed to be very powerful although they also have a lower weight and a less inertia. This motor creates zero rpm torsion that generating an extremely inexpensive nursing companion achieves high power density compared to an induction motor. However, this motor requires a duty engine.

In order to satisfy the demands of low-speed , high performance and high resistance, this engine uses a variable frequency motor. However, the VFD management technique will increase the performance of the machine and thus requires a careful management of its rpm. So the price of this engine lies in the upper facet relative to the induction motor.

II. The Stepper Motor

This motor is similar to the BLDC engine but is powered by a bended signal to create a lower force. The curved distribution of the multifaceted stator coil winding creates a curved density inside the airspace that is totally distinct from the BLDC quadrilateral density. The engine has a similar induction engine and brushless dc engine feature. The motor features a magnet rotor, which winds on its stator coil. The stator coil of this engine should be bent in a density equal to the equivalent motor induction density. The efficiency density of this motor is higher than inductive motors of equivalent values, since there is no stator spiral power dedicated to magnetic stream output. These engines are today built to be very powerful, even though they are also less large and less inertia-producing. This motor produces resistance at zero rpm, with a highly economical amount of related density compared to an induction motor. However, this engine needs a power drive. In order to meet the requirements of high speed , high density , and high performance, this engine uses a variable frequency motor. However, the VFD management technique will increase the performance of the machine and thus requires a careful management of its rpm. Therefore, the output of this engine is on the upper side in comparison to the induction engine.

III. Switched Reluctance Motor

Owing to the lack of coils inside the rotor, the rotor inside the Switched Reluctance motor (SR) does not produce field around itself, so no reactive force is produced in the switch reluctance motor. If a stator coil component is energized, force is produced in these motors, the stator coil pole combine draws the closest rotor pole combine towards the poles orientation. This creates a high-torque ripple that leads to acoustic noise and vibration. However, due to its simplistic style, the SR engine is incredibly economical to manufacture, and is undoubtedly the most powerful engine on the market. Compared to the stepper motor, this motor generates comparatively less force. Therefore, its use in the implementation of work units is not common.

B. Asynchronous Motor (Induction Motor)

The electromagnetic induction from the field of the stator winding generates the current in the rotor winding throughout this motor. The rotor current remains used for the torque output. The most regular asynchronous motor available is the induction system. The electromagnetic induction from the stator winding field induces the current in this motor in the rotor winding. The torque output is also used for the rotor present. The devices are normally powered by a 2-tier normal vector-controlled motor that makes a wide range of operations at rpm, as seen in Figure 3. These instruments, which are dictated by the design choices of the system management and electronic control of the fuel, are characterized by three distinct operating systems, namely the constant torque, the constancy and reduced power areas.

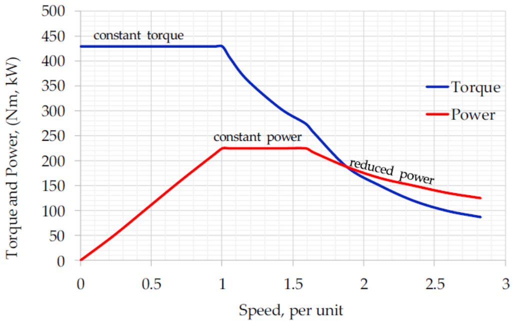

Fig. 3-Torque speed curve of the induction machine

IV. DIRECT CURRENT (D.C.) MOTORS

The numerous available DC motors are discussed in this section. Motors such as brushed DC and Brushless DC are seen in terms of their respective strength, efficiency and cost.

A. Brushed DC motor

A brushed DD motor consists of associated degree brushes of an electric switch that transform a DC current into an AC current in the associated degree coil. The magnet force field repels the magnets by the same polarity, so that the winding shows the attractive magnets with the opposite polarity. The electric switch reverses the existing inside the coil as the coil spins, repelling the close magnets, allowing the motor to flip unceasingly. DC power can drive this engine, so it is terribly desirable for inexpensive applications. However, some drawbacks of the brushed DC motor field are caused by the arcing produced by the coil coils on the brush-commutator surface that generates heat, wear, and magnetic force interference (EMI). These properties of the brushed engine indicate that it is also suitable in applications where high power is not a major concern. This makes the use of this kind of motor less attractive in energy unit applications.

B. Brushless DC motor

The brushless DC (BLDC) engine area unit is the most popular and wide-ranging unit used in single-phase, 2-phase and 3-phase control and area programmes. For various applications for general purposes, the fundamental structure, robustness, and low cost of a BLDC engine make it a feasible alternative. In conjunction with an appropriate regulated unit, the BLDC offers several required characteristics for the economic drive system of the associate degree. In contrast with alternative electric motors, one big advantage of BLDC is improved speed versus force characteristics. In addition, the BLDC conducts mechanical abuse of commutation rotor location feedback to carry out how to adjust the current. To make this motor, a magnet rotor and wire-wound stator coil poles are used. The rotor is constructed from a magnet and can move from two-pole to eight-pole pairs of alternating North (N) and South (S) poles. For the permanent magnets on the rotor, the stator coil windings work to come up with an equal flux inside the air gap. This allows a continuous DC voltage to drive the stator coil coils (hence the brushless DC name). The rotor location of the mistreatment hall outcome sensors sensed by a BLDC is highly important, supplying the winding data that is energised at the moment and also the winding that can be energised in series. They have a high or low signal if the rotor magnetic poles pass near to the hall sensors, indicating that the N or S pole passes near to the sensors. It is possible to determine the exact commutation order, depending on the mixture of those 3 signals of the hall unit.

In addition, the position sensors may be replaced by less control means for the transmitter, thus reducing the motor 's value and capacity. In particular, control techniques such as back-EMF and current sensing may provide ample information to correctly approximate the rotor position and thus to operate the engine with synchronous component currents. Maybe one technique known as the zero crossing objectives (ZCP) is embraced by the most standard BEMF techniques, having the primary purpose of generating the rotor location information at either 00 or 1800 electricity. A portion change of three hundred or 900 to balance the commutation instances succeeds in the zero crossing intent methods. Any ZCP detection error ends up in the sub-optimal current of the component.

It is recommended to use an abstract technique that uses extended kalman filters to estimate the exact commutation instance of a winding. This approach is planned, true and alleged to be more advanced.

The BLDC motor provides excellent power density , higher torsion, decreased operating and mechanical noise, and avoidance of magnetic force interference relative to certain motors, and provides excellent power. Therefore, the hottest EV software is this engine.

V. THEORETICAL ANALYSIS

An attempt to research 5 numerous electric motors on numerous paradigms for electric vehicle application has been created. The incidental highlights can be illustrated by relative evaluations

1. Square DC motors are tough to handle, offer giant torsion at reduced speeds, but have a considerable support expense, expansive structure, and low effectiveness.
2. BLDC motors have advanced power output, high efficiency and low scale, but they hold prices up.
3. Productivity over ninety one is given by 3-phase IM. In addition, they require extreme fidelity, low power density and considerable space, ease, and average acceleration. The 2 most well-liked engines by work unit producers are measured by BLDC motors and 3-phase IM square.
4. At lower accelerations, synchronous devices have greater skill and increase power use and propulsive size. Where steady torsion is needed, the electric motor is preferred.
5. SRMs provide a rare possibility with motor/controller price being terribly less, responsibility, smart potency, and adaptation to internal failure capability.

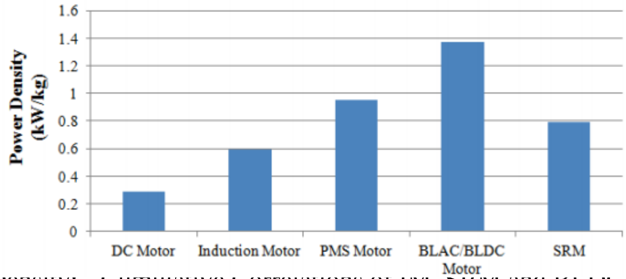

Fig 4- Power Density: - Cumulative Correlations of IM, SRM and BLDC/BLAC Motors

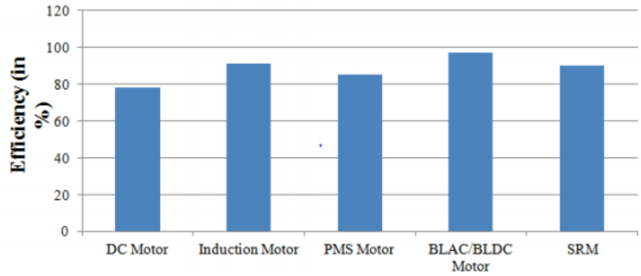

Fig. 5- Efficiency:- Cumulative Correlations of IM, SRM and BLDC/BLAC Motors

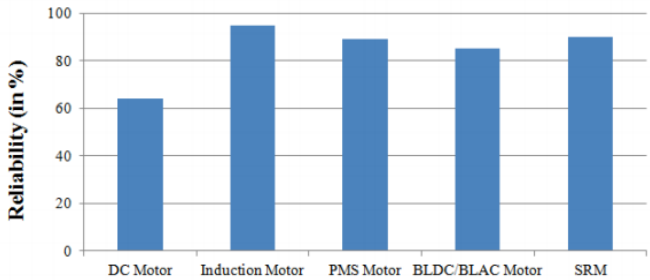

Fig. 6- Reliability:- Cumulative Correlations of IM, SRM and BLDC/BLAC Motors

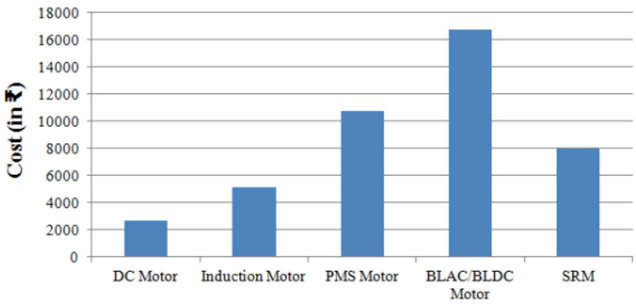

Fig.7- Cost Factor:- Cumulative Correlations of IM, SRM and BLDC/BLAC Motors

VI. CONCLUSION

A analysis of different engines used as electrical drive trains is given in this article. Operating values, operating criteria, fantastic choices and drawbacks of all engines on the market square measure are very well listed and given. The brushless DC engine has sought to be an economical choice for electric drive train applications. This motor has a strong output and outstanding power efficiency and is low on the market. Furthermore, this engine is often known as an electric drive train.

The fundamental goals that would be taken from this paper are:

1. The induction engines and even the PM brushless motors are measured by the most widely used square motors.

2. Square induction motors calculate the most savvy of the motors considered.

3. Taking strength into account, the PM BLDC engines calculate the most effective square distance.

4. As a good deal of work has been performed on them over the years, DC motors have been a leader among the most innovative inventions.

5. The IMs and even the square SRMs assess solid improvement and require minimal maintenance assessment

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ITEM					
Max. Output(kW)	4.5	7.5	100	120	80
Max. Speed	6,000	8000 r/min	12,500 r/min	9,000 r/min	10,000
Torque(N.m)	90	190	300	600	250
Type	IM	IM	IM	IM	Pma_SynRM
Cooling	Self Coolded	Self Cooled	Water	Water	Water
Application	Golf Car	Micro Mobility	SUV(FCEV)	Delivery Truck	Compact Car

ITEM					
Max. Output(kW)	25	110	100	120	150
Max. Speed	10,000 r/min	10,000 r/min	5,000 r/min	9,000 r/min	3,500
Torque(N.m)	40	330	660	600	600
Type	IPMSM	IPMSM	IPMSM	IPMSM	PMSM
Cooling	Water	Water	Water	Water	Water
Application	HEV Generator	Truck	Truck	Small Bus	Motor Car

Fig. 8. EV Motor Design

ITEM					
Model	eVi1P08-V35	eVi2P10-V65	eVi3P15-V65	eVi4P20-V65	PHEVP20-V65
Output [kW]	40/80	50/100	75/150	100/200	100/200
Rated Voltage [Vdc]	350	650	650	650	650
Operation Voltage [Vdc]	12~24	12~24	12~24	12~24	12~24
Output Current [Arms]	150/300	150/300	200/400	300/600	300/600
Cooling	Water	Water	Water	Water	Water
Protection Level	IP67	IP67	IP67	IP67	IP67
Dimension [mm]	267*284*107	301*362*112	301*420*120	498*374*129	499*315*174
Weight [kg]	9.4	12	16	25	28

Fig.9. EV Drive