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Analysis of Comparison and Selection of BLDC Motor for Electric Vehicles

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Abstract: **This paper proposed the BLDCM (Brushless Direct Current motor) entirely meet the requirements of an EV propulsion system. Despite having the maximum power density, PM Brushless DC motors have a complicated control strategy. The auxiliary field winding in permanent magnet Hybrid motors (PMH) allows for maximum efficiency across a variable range of speed . Hence flux in the air gap is made up of both field winding and permanent magnet flux, each of which has a unique magnetic path. Switched Reluctance Motors (SRM) are strong due to their dependability and ease of fabrication. It delivers superior heat distribution, a wide speed range at constant power, and high beginning torque.SRM drives with sliding mode control can be used with electric vehicle propulsion systems. The provides a simple comparison of the motors based on their performance.**

Key Words**: BLDC, Motor specifications, Torque, Aerodynamics, Resistance**

I.INTRODUCTION

An electromagnetic excitation the permanent magnets (PM) has a number of benefits, including no excitation losses, a simpler design, dynamic performance, improved efficiency and maximum power or torque per unit volume. Brushless DC motors use a system of electronic commutation instead of brushes for a mechanical commutation system.it is driven by direct current energy (DC). In such motors, the relationships between current, torque, and voltage are linear. In a BLDC motor, the permanent magnets rotate in place of the electromagnets, which remain stationary. As far as their structure is concerned, modern permanent magnet synchronous motors resemble unit.[1]-[5]

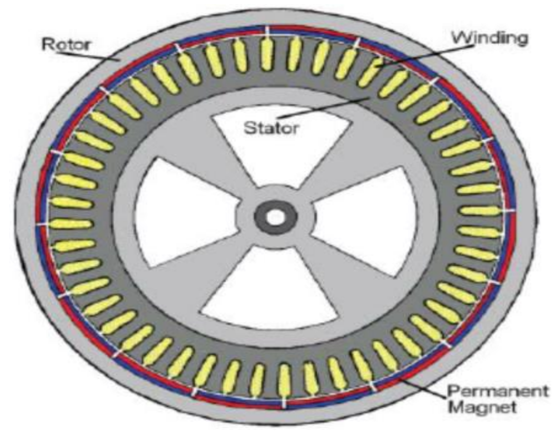

Fig 1. Cross section view of a brushless DC motor

The general layout of a three phase brushless dc motor is shown in Figure3. While the stator windings replicate those of a polyphase ac motor, the rotor is made up of a number of permanent magnets. Brushless dc motors operate electronic switches by creating signals based on the rotor position, as opposed to ac synchronous motors. Although the hall element is the most common position/pole sensor, other motors employ optical sensors. Even though three phases motors have the biggest outer box and are more efficient, brushless dcmotors can also be used for simple construction and drive circuits.[2]-[5]

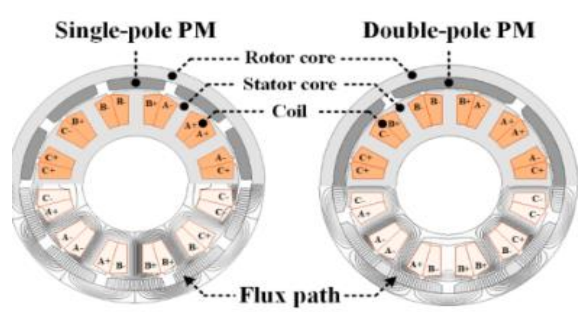

Fig.2. Brushless dc motor(Two phase)

II. COMPARISION OF MOTORS

Table 1. Comparision of motors specifications

Parameters	PM Brushless DC motors (PMBLDC)	Switched Reluctance Motors (SRM)	Induction Motor(IM)	permanent magnet Hybrid motors(PMH)
Torque Vs Speed	10	10	10	10
Power Density	10	6	5	8
Overall Efficiency	8	6	6	10
Robustness	8	10	8	8
Temperature	10	10	8	8
Status	8	6	10	6
Total	54	48	47	50

From the table 1, electrical machines, mechanical device which converts a input from one level to another. EV power supply designs manifest the need for at the minimum one converter(DC/DC) to connect the Frequency Controller(FC},Super Capacitors(SC) or Battery to the DC-link. Electric field storage components (capacitors) or magnetic field storage components (inductors, transformers) may be used for the storage.[3]-[5]

III.DC-DC CONTROLLER

It is possible to make nearly all DC/DC converter topologies bi-directional, Nevertheless a bi-directional converter is useful in situations needing regenerative braking since it can transfer power in either direction. By altering the duty cycle (the switch's ratio of on/off time), it is possible to regulate the amount of power flowing between the two sides. Usually, this is done to maintain a steady power, manage the output voltage, or the input and output currents. Converters built on transformers could offer input and output isolation. Complexity, electrical noise, and high cost for particular topologies are the main downsides of switching converters.[5]-[7]

IV.PERFORMANCE ANALYSIS

Calculation of BLDC Motor:

P=1000W,V=48VP=V×I

I=1000÷48=20.83Ampere.

Calculation of Motor Speed:

Speed (N)=K÷(d×0.001885)

=35÷(25.4×0.001885)

731

Revolution per Minute(RPM)d=Wheel diameter in cm

1.inch=2.54cmd=10 inch

Hence d=25.4 cm

Torque equation of Motor(T):

T=(1000×60)÷(2×N)

=(1000×60)÷(2×3.14×731)

=13.06 NM

Motor Selection:

For calculating the vehicle power rating the following parameters are considered

A.Rolling Resistance

B.Gradient Resistance

C.Aerodynamic Resistance

Gross weight of 170kg e-scooter is chosen for selection of motor ratingRequired force for operating vehicle is

Ftotal = Frolling + Fgradient + Faerodynamic drag

A motor’s output should overcome a cumulative tractive force before it can move a e-scooter

A.Rolling Resistance

An automobile's tires provide resistance to the road when they contact it.

Frolling = M × g ×Cr

rMass in kg

g-Acceleration due to gravity =9.81m/s2Crr=0.004

Weight of e-scooter =175kg

Table 2.Co-efficient Rolling Resistance

Railroad steel wheels on steel rail	0.001to0.002
Two wheeler on	
Wooden track	0.001
Concrete	0.002
Asphalt road	0.004
Rough paved road	0.008
Truck tire on asphalt	0.006to0.01
Four wheeler on	

concrete	0.01to0.015
Tar or Asphalt	0.02
Gravel-rolled new	0.02
Gravel-large worn	0.03
Solid sand, gravel loose worn and medium hard	0.04to0.08
Loose sand	0.2to0.4

Frolling =M ×Crr×g =175×0.004×9.81=6.6708N (Newton)

V.GRADIENT RESISTANCE

In a vehicle, a gradient resistor is what provides resistance to the vehicle while climbing hills or crossing flyovers. A sloped path is represented by an angle between the ground and slope, as shown in the following figure .

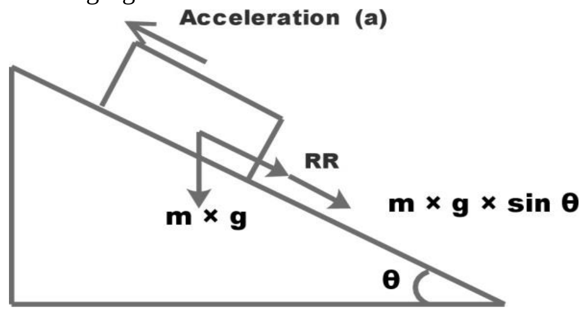

Fig 3.Diagram of a moving vehicle Inclined surface.

Fgradient resistance = ±M × g × sin θ

The gradient is denoted by a positive polarity sign for movement upward and a – negative polarity for downward. Regarding applicability, Let's use an electric scooter operating at an inclined angle of =3.50 as an example.

Gradient Force (Fgradient)=170×9.81×sin2.5 =72.7440N

VI.AERODYNAMIC DRAG

Viscose forces provide a vehicle's aerodynamic drag, which is a resistive force. It linearly influencesby its shape

Faerodynamic drag = 0.5×CD×Af×ρ×v2Af=Frontal area, CD=Drag coefficient V=Velocity in m/s

ρ=Air density in kg/m3

For example scooter maximum speed is 35kmph which is 12.5m/s and density of air is 1.1644kg/m3at around 40° temperature and coefficient of drag is 0.5, frontal area is 0.7 which is available in the below table.

Table 3.vehicle Drag coefficient and frontal area

Vehicle	CD	Af
Two wheeker with rider	0.5 to 0.7	0.7 to 0.9
Carriage	0.4 to 0.8	6 to10
Truck		
without trailer	0.45 to 0.8	6.0 to10.00
with trailer	0.55 to 1.0	6.0 to10.0
Articulated vehicle	0.5 to 0.9	6.0 to10.0

Faerodynamic drag=1/2×CD×Af×ρ×v^2

=0.5×0.5×0.7×1.1644×[9.72 222]2=19.2606N

Total driving force for operating EV is,

Ftotal = Frolling + Fgradient + Faerodynamic drag

=6.6708+72.7440+19.2606

=98.6754N

P(Total)=Velocity×Force×(1000÷3600)

=98.6754×40×0.277

=959.344 watt

To propel the vehicle the total power requirement is 959.344 W,which is safe design because the rating and it is below motor specification 1000 W.

Battery Design

W=1000 W,Voltage=24V

In battery 80% charge is utilized and the remaining is 20%.Hence 1200w.hr=1000 w.hr×1.20

Battery current (Ah)=1200w.hr÷48v=25Ah

Battery charger Selection

Sometime the battery takes 5 hr for optimum charging.

Hence charger wattage =1200w.hr÷5hr=240w

Ampere rating of charger =240w÷48=5A

48v, 5A charger is need for charging 48v,25Ah battery in 5 hour

VII.CONCLUSION

The use of fuel-powered vehicles increases rapidly today, which leads to more air pollution. Electricvehicles are pollution free product, which makes them more adaptable for city use due to their ability to reduce air pollution by not emitting harmful gases. Compared to a traditional vehicle, the electrically charged vehicle has been seen as the most economical because fuel prices have been increasing frequently. Therefore, this paper focused on EV two-wheeler design including overview of Electric Vehicle technology and its enormous components and the prototype is available

REFERENCE

[1] S. S. Rauth and B. Samanta, "Comparative

Analysis of IM/BLDC/PMSM Drives for Electric Vehicle Traction Applications Using ANN-Based FOC," 2020 IEEE 17th India Council International Conference (INDICON), New Delhi, India, 2020.

[2] T. -Y. Lee, M. -K. Seo, Y. -J. Kim and S. -Y. Jung, "Motor Design and Characteristics Comparison of Outer-Rotor-Type BLDC Motor and BLAC Motor Based on Numerical Analysis," in IEEE Transactions on Applied Superconductivity, vol. 26, no. 4, pp. 1-6, June 2016, Art no. 5205506, doi: 10.1109/TASC.2016.2548079.

[3] H. -W. Kim, K. -T. Kim, Y. -S. Jo and J. Hur, "Optimization Methods of Torque Density for Developing the Neodymium Free SPOKE-Type BLDC Motor," in IEEE Transactions on Magnetics, vol. 49, no. 5, pp. 2173-2176, May 2013, doi: 10.1109/TMAG.2013.2237890.

[4] D. Zhao, X. Wang, B. Tan, L. Xu, C. Yuan and Y. Huangfu, "Fast Commutation Error Compensation for BLDC Motors Based on Virtual Neutral Voltage," in IEEE Transactions on Power Electronics, vol. 36, no. 2, pp. 1259-1263, Feb. 2021, doi: 10.1109/TPEL.2020.3006536.

[5] H. -K. Kim, J. -H. Park and J. Hur, "Comparison Analysis of Demagnetization and Torque Ripple in Accordance With Freewheeling Current in PM BLDC Motor," in IEEE Transactions on Magnetics, vol. 51, no. 11, pp. 1-4, Nov. 2015, Art no. 8108204, doi: 10.1109/TMAG.2015.2433933.

[6] Z. Zhang, Z. Deng, C. Gu, Q. Sun, C. Peng and G. Pang, "Reduction of Rotor Harmonic Eddy-Current Loss of High-Speed PM BLDC Motors by Using a Split-Phase Winding Method," in IEEE Transactions on Energy Conversion, vol. 34, no. 3, pp. 1593-1602, Sept. 2019, doi: 10.1109/TEC.2019.2898640.

[7] K. -T. Kim, J. -K. Park, J. Hur and B. -W. Kim, "Comparison of the Fault Characteristics of IPM-Type and SPM-Type BLDC Motors Under Inter-Turn Fault Conditions Using Winding Function Theory," in IEEE Transactions on Industry Applications, vol. 50, no. 2, pp. 986-994,

[8] L. S, D. RM, A. Chowdhury and S. Krishna, "Analytical Design of 3Kw BLDC Motor for Electric Vehicle Applications," 2023 3rd International Conference on Intelligent Technologies (CONIT), Hubli, India, 2023, pp. 1-7, doi: 10.1109/CONIT59222.2023.10205842

[9] G. Thenmozhi, A. Radhika, B. Mithun, M. Dhineesh and B. Abissek, "A simulation-based investigation on the Performance of BLDC motor used in Electric Vehicles for varied magnetic materials," 2022 8th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2022, pp. 875-879, doi: 10.1109/ICACCS54159.2022.9785117.

[10] Rupam and S. Marwaha, "Performance Analysis of BLDC Motor using MATLAB Simulation," 2023 International Conference for Advancement in Technology (ICONAT), Goa, India, 2023, pp. 1-4, doi: 10.1109/ICONAT57137.2023.10080400

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