LOAD VARIATION ANALYSIS OF BLDC MOTOR PROPELLING AN ELECTRIC VEHICLE USING MOTOR CAD SOFTWARE

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Abstract: An electric drive vehicle, or simply electric vehicle (EV), is a vehicle based on one or multiple motors (electric or traction) to ensure propulsion. The degree of electrification varies from one hicle to another. An electric vehicle (EV) is a vehicle based on one or multiple motors to ensure propulsion. The degree of electrification varies from one vehicle to another along with the type of motor used. Electric vehicles are much more energy efficient. Electric motors convert virtually all of their fuel energy into usable power. There are many benefits of using electric vehicles such as no fuel odour as the vehicles operate on batteries, not on gasoline, diesel, or some other type of combustible fuel. The selection of electric motor for electric vehicles is a very important task in front of manufacturer keeping in mind the efficiency and losses. Different types of motor can be used and they have different effect on vehicle performance based upon specification, parameters and designing. In this paper an overview of Brushless DC Motor (BLDC) and its design and analysis is presented using motor cad software. Their main advantages are high efficiency, compactness and high energy density.
Keywords: Brushless DC Motor, efficiency, load variation,motor cad software.

I. INTRODUCTION

Electric vehicle (EV) is one of the alternatives to conventionalInternal combustion engine (ICE) powered vehicle due to pollution free environment, cost and availability of the oil. Now a days we are facing lot of different crisis caused by high oil prices and obsolete designs which have prompted the search for more efficient road vehicles, possibly based on environment friendly sources located in politically stable areas. This has led to the development of electric vehicles [1].Basically four types of motor drives have been applied to EVs. They are brushed DC motor drives, induction motor drives, switched reluctance motor drives, and permanent magnet brushless DC motor drives.The specification of the motor/generator depends on its usage, like in light/medium/heavy duty vehicles, off/on highway vehicles and locomotives. The performance of the machine depends mainly on vehicle duty cycle, thermal characteristics and the cooling mechanism implemented. Invention of power converter topologies for drive control has advanced the traction systems for EVs over recent years.Permanent magnet brushless dc motor (PMBL) is a very promising technology that has been in wide. BLDC motors are theoretically the result of reversing the position of the stator and rotor of PM DC motors. Their main advantages are high efficiency, compactness and high energy density. In [2], brushless DC motor using motor cad software was proposed for EV applications.By correctly using regenerative braking, electric vehicles achieve greater brake life as well as create energy through kinetic energy.

II. PERMANENT-MAGNET BRUSHLESS DC (PMBLDC) MOTORS

The BLDC motor is a kind of brushless permanent-magnet motor with the trapezoidal back electromotive force (back-EMF) waveform and rectangular excitation current [3]. Before the latest incarnation of electric vehicles, cars already used BLDC motors for windshield wipers, CD players, and power windows. Fig 1. Shows the basic conventional pmbldcmotor.The BLDC motor has a permanent-magnet rotor surrounded by a wound stator. The winding in the stator get commutated electronically, instead of with brushes. This makes the the BLDC motor Simpler to maintain, More durable, Smaller and Able to respond faster and at higher operating speeds. The composition of the BLDC motor also keeps the machinery inside a vehicle cooler and thermally resistant. Plus, because the motor is brushless, there is no dangerous brush sparking. Manufacturers often prefer BLDC motors over the alternatives because the peak point efficiency is higher and rotor cooling is simpler. The motors can also operate at "unity power factor," meaning the drive can operate at its maximum efficiency levels.

PMBLDC MOTOR

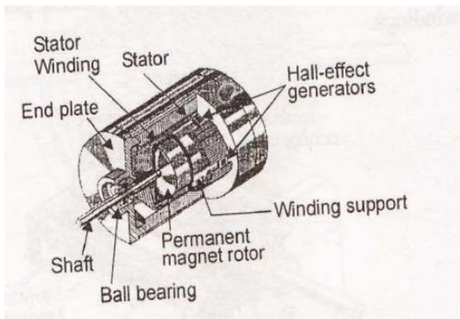

Fig 1: Conventional PMBLDC Motor

It's currently more expensive to manufacture than its brushed counterparts. Also, the magnetic field produced by the permanent magnets isn't adjustable. Scientists hope to make the strength of the magnetic field more adjustable so when an electric vehicle requires maximum torque, particularly at low speeds, the magnetic field will be at maximum strength. Electronic commutation technique and permanent magnet rotor cause BLDC to have immediate advantages over brushed DC motor and induction motor in electric vehicle application [4]

Motor-CAD Software:
It is a dedicated electric machine design tool for fast multiphysics simulation across the full torque-speed operating range. Motor-CAD enables design engineers to evaluate motor topologies and concepts across the full operating range, to produce designs that are optimized for performance, efficiency and size. Motor-CAD software's four integrated modules—EMag, Therm, Lab, Mech—enable multiphysics calculations to be performed quickly and iteratively, so users can get from concept to final design in less time. Motor-CAD's intuitive, template-based setup simplifies and automates the analysis process while its built-in electromagnetic, thermal and mechanical solvers offer valuable multiphysics insights into a motor design. The simulations can be completed in a matter of seconds thus allowing ample time and scope for extensive design space exploration. Ansys Motor-CAD enables engineers to produce optimized electric motor and generator designs to help meet the size, weight, energy efficiency, cost and other specifications.

III. DESIGNING OF BLDC USING MOTOR-CAD

Motor-CAD enables design engineers to evaluate motor topologies and concepts across the full operating range, to produce designs that are optimised for performance, efficiency and size.

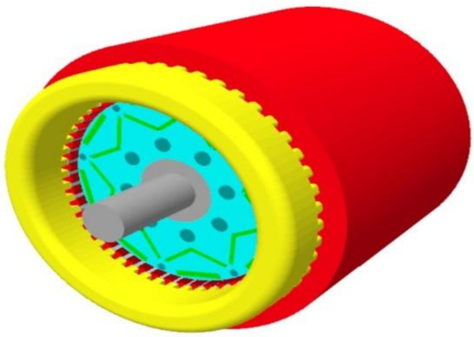

Fig 2: Design of BLDC Motor using motor cad software

Speed-Torque Characteristics of the Motor-Load Mechanisms:

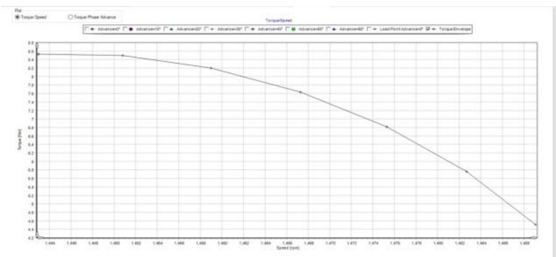

FIG 3 Speed-Torque Characteristics

The speed torque characteristics of a motor is given by the relation

$\omega=f(TL)$ eq.1

It is defined as relationship between the speed at which it is operated and the load torque. Speed torque characteristics of different kinds of load are divided into the following categories:

Load with Constant torque at all speeds:
This kind of load offers passive torque to the motor which is essentially independent of the speed. Examples of such load are dry friction, cranes during hoisting, hoist winches, piston pumps operating against a constant pressure head and conveyors.

Load with linear- rising characteristics:
In this type of load the load torque TL rises in direct proportion to the speed. Popular example is calendaring machine.

Load with non- linear falling (Hyperbolic) characteristic:
For such type of load, the torque TL is inversely proportional to the speed while power required to drive the given unit remains unchanged. Certain types of lathe, boring machine, milling machine and other kinds of metal cutting machine, steel mill coilers fall under this category of loads

Load with non- linear rising (Parabola) characteristic:
In this type of load, the load torque TL is proportional to the square of the speed. Windage torque is the dominating component of this load. Different examples are Fan, Blowers, Centrifugal pumps, Propellers in ships or aeroplanes, water wheels, etc.

Load -Torque Variation versus Time Characteristics for Different types of Load:
Torque Required Propelling the Vehicle:

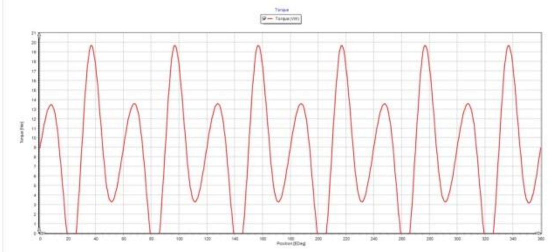

FIG 4 Load –Torque characteristic

Variation of load-torque with time is of equal or greater importance in selection of motor. This variation in certain applications can be periodic and repetitive. One cycle of variation is called a duty cycle. Different types of load having different load characteristics are classified as follows.

Continuous constant load:
These loads operate for a long time under the same condition. Examples are paper making machine, centrifugal pumps, etc.

Continuous variable load:
Hoisting winches, metal cutting lathes, conveyors are the examples of continuous variable type load.

Pulsating load:
Reciprocating pump, textile looms and all machines having crank shaft come under this type of load.Short- time load:
Examples are motor generator set for charging of batteries, servo motors used in remote control of drilling machine and clamping rods.

Short-time intermittent load: Crane and hoisting mechanism, excavators, and roll train are examples of this type of load.

IV. CONCLUSION

This article presents the brushless DC motor designed to compensate the load torque variations. The paper deals with various load –torque variation and its effect on the performance on bldc motor.

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