ISSN (Online) 2456-1290
International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 1, Issue 7, November 2016

Implementation of Direct Drive Technologies into Electric Vehicles

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Abstract:-- **"The development of electrical direct drives has reduced the need for mechanical drive components for several machines. A Direct Drive Technology is one that takes the power coming from a motor without any reduction, i.e. no transmission components are used. In our case study, we have approached a theory on removing the transmission parts of automobiles such as shafts, chains, belts. And to use the direct drive motor to the wheel. A design is in progress to fit the field coils into chassis and the permanent magnets are placed on the wheel's rim. The field coil is connected to a battery and becomes temporarily magnetized once the circuit is closed. The motion is achieved due to the attraction between the field coil and the magnetic strip. A magnetic flux shield is being put to use to avoid unnecessary attraction of ferrous materials presents on the road. This new technology significantly improves the overall efficiency of Automobiles."**

Key words: Electric Vehicle, Efficiency, Direct Drive

Abbreviation: Electric Vehicles – EV's , Internal Combustion's – IC's

I. INTRODUCTION

The direct drive motors came to existence and being developed from past decade. They have proved to have better efficiency than any other motors in the market. The design of this motor is in progress, certain drawbacks of it are to be reduced.

The present state of automobiles hasn't seen any evolvement in implementing electric powered vehicles. In majority, every vehicle we see on road are IC engine powered vehicles. Till date only 1,300,000 electric vehicles operational and on whole 1.2 Billion automobiles are operating. Which is 0.0001% percent of EV's on the road.

The motive would be that make an effort to complete transition towards the electric vehicles and make them more efficient.

II. RELATED WORK:

There have been several papers published in many platforms. We have gathered few papers which are related to our field. Most commonly written ones are of using a hybrid vehicles. We are in brink of being consumed in to an apocalyptic age of global warming. The idea is make a complete transition towards EVs. It is true that every idea has its own pros and cons. The hybrid electric vehicle consists of two or more energy sources for total propulsion of the vehicle. Two independent propulsions, ICE and electric motor are independently operated for combined effort derivation in total propulsion of the vehicle. So the problem is that user has complexity for using a two different sources. As a usual practice of human being they are onto a fossil fuel. There is a minimum chance that the user charges the battery for additional power.

Solar Electric bikes are eco-friendly i.e. zero emission. The maintenance cost is low. Additional to the plug key, the batteries could also be charged by the solar panels.

However these bikes travel less distance per charge which makes them less dependable. The batteries are expensive and the weight of the battery add to the woe. The motors and controllers constitute to the cost.

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Finding the results of similar papers, they might be good for starting phase of introduction to the EVs. To prove the true potential of the EVs we have to present the world the most efficient machines possible by mankind.

The technology at the present stage is more advanced than they were first introduced in early 1800's by Thomas Davenport. They had Non rechargeable batteries. Where the technology was little behind with Rechargeable batteries not yet been inverted. After few decades the first electric car been introduced, Rechargeable batteries came to existence. Then evolution of the EVs started.

Every study on EVs are similar to its design and procedure. Using a controller, DC (or) AC Motor, throttle and battery. These are main components of a general EV. A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. The motor is the source of power for the EV. The batteries are electric source for motor and controller.

System Model:

Our theory is based on the basic laws of magnetism. Speaking of the two-wheelers, the chassis consists of field coil wound towards its end which is capable of acting as electro magnets when the power is supplied. The swing arm is designed according to our needs and instead of a traditional mud guard we have used a coil head as depicted in the figure.

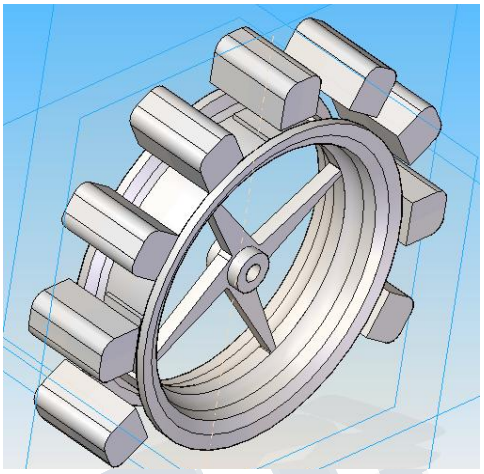

Fig: 1 the wheel with Coil Head

The wheel is specifically designed to hold the permanent magnets. They contain slots to place each one them. Below the CAD image shows how the magnets are to be placed.

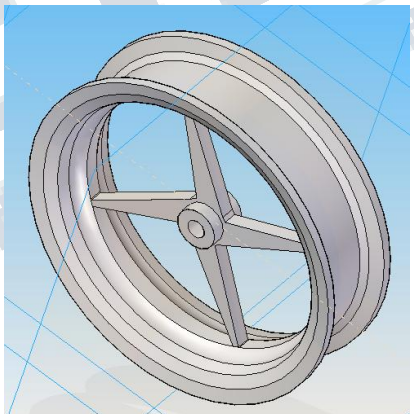

Fig: 2 The Rim without Magnets

Fig: 3 The Rim with Magnets

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In our case study we have assumed that there are no material present on the roads which could get attracted by the magnetic field. Our design is no different to an hub motor with the only difference being that in a hub motor, the stator and rotor are present as a single unit inside the motor itself and in our design, they are separated placing the stator in the chassis and the magnets on the rim of the wheel, which in turn reduces the weight of the wheel and not concentrating the whole weight on single connection of hinge.

The EV uses the magnet which has the different polarity to the corresponding EM coil and generate the attractive force. Attractive force, then will be high enough to overcome frictional force (or) Inertia and allows it to generate Torque.

III. THE COMPONENTS:

1. Controller:

A control is the most important component present in any EV. It is the key for the realization of a high performance electric vehicle with an optimal balance of maximum speed, acceleration, performance and travel range per charge.

In general a controller could be called as a device installed on an EV which controls its speed and thereby ensuring the safety of the rider. With the arrival of programmable control chips, it has now become easier to accomplish function of capacity detection, under voltage protection(When the battery pack falls below a specific Voltage the controller turns the motor off preventing over discharging of the battery pack which extends the battery packs lifespan) and so on. In conventional EV's, without the controllers the motors then to us more energy and thus rapidly depleting charge and also reduces the battery life.

2. Core:

In general, a core can be defined as a piece of soft iron inside the windings of an electromagnet that channels the magnetic field. When the coil of any ferrous material is wound around a core and if the current is passed through the coil then the coil becomes a temporary electro magnet having the properties of a permanent magnet, till the current supplied to the coil is stopped. The heat generated in the coil (H) due to the flow of a current (I) can be determined by using the equation,

$H = I^2R$

Magnetic permeability is one of the important terms associated with the core. Permeability could be defined as the measure of the ability of a material to support the formation of a magnetic field within itself. Hence magnetic permeability could be defined as the degree of magnetization that a material obtains in response to an applied magnetic field.

If cores of different materials with the same physical dimensions are used in the electromagnet, the strength of the magnet will vary in relation to the core material being used. This variation in the magnetic strength is due to the number of flux lines passing through the central core. If the magnetic material has a high permeability then the flux lines can easily be created and pass through the central core and permeability (μ) and it is a measure of the ease by which the core can be magnetised. Ideal Material for the Winding coil would be Iron.

3. Winding wire :

The wire or conductor which constitutes the coil is called the winding. The hole in the centre of the coil is called the core area or magnetic axis. Each loop of wire is called a turn. In windings in which the turns touch, the wire must be insulated with a coating of nonconductive insulation such as plastic or enamel to prevent the current from passing between the wire turns. The winding is often wrapped around a coil form made of plastic or other material to hold it in place. The ends of the wire are brought out and attached to an external circuit. Windings may have additional electrical connections along their length; these are called taps. A winding which has a single tap in the centre of its length is called centre-tapped.

Coils can have more than one winding, insulated electrically from each other. When there are two or more windings around a common magnetic axis, the windings are said to be inductively coupled or magnetically coupled. A time-varying current through one winding will create a time-varying magnetic field which passes through the other winding, which will induce a time-varying voltage in the other windings. Ideal Material for the Winding coil would be copper.

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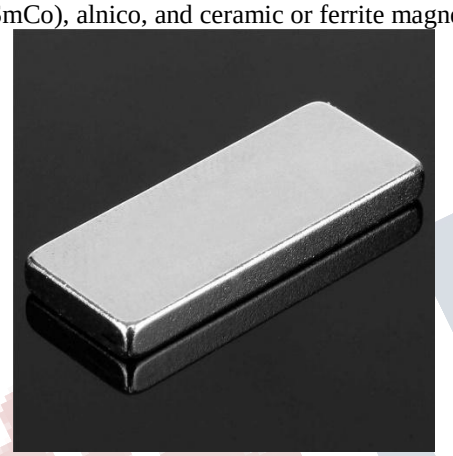
4. Permanent Magnets

There are typically four categories of permanent magnets: neodymium iron boron (NdFeB), samarium cobalt (SmCo), alnico, and ceramic or ferrite magnets.



Neodymium Iron Boron (NdFeB)

This type of magnet is composed of rare earth magnetic material, and has a high coercive force. They have an extremely high energy product range, up to 50 MGOe. Because of this high product energy level, they can usually be manufactured to be small and compact in size. However, NdFeB magnets have low mechanical strength, tend to be brittle, and low corrosion-resistance if left uncoated. If treated with gold, iron, or nickel plating, they can be used in many applications. They are very strong magnets and are difficult to demagnetize.

Samarium Cobalt (SmCo)

Like NdFeB magnets, SmCo magnets are also very strong and difficult to demagnetize. They are also highly oxidation-resistant and temperature resistant, withstanding temperatures up to 300 degrees Celsius. Two different groups of SmCo magnets exist, divided based on their product energy range. The first series (Sm1Co5) has an energy product range of 15-22 MGOe. The second series (Sm2Co17) has a range that falls between 22 and 30 MGOe. However, they can be expensive and have low-mechanical strength.

AlNiCo

Alnico magnets get their name from the first two letters of each of three main ingredients: aluminium, nickel, and cobalt. Although they feature good temperature resistance, they can easily be demagnetized and are sometimes replaced by ceramic and rare earth magnets in certain applications. They can be produced by either sintering or casting, with each process yielding different magnet characteristics. Sintering produces enhanced mechanical traits. Casting results in higher energy products and enables the magnets to achieve more complicated design features.

Problem Statement:

The evolution of vehicle's transmission hasn't changed much. The efficiency, design, mode of transmission, the material used, are the factors came to consideration of modification. Following are the presenttransmissions are currently under use.

Chain Drive:

A chain drive is usually preferred mechanism in transmission owing to its greater efficiency and lower cost. Chain drive uses two sprockets, one by the engine (or the motor in case of EV's) and one by the rear wheel. The connections are so given that when the motor rotates, it in turn rotates the rear wheel. Chain drive despite being economical, it does, however, come with some demerits. Chain Drive requires a lot of maintenance, its sprockets and chains wear faster than belt drive or shaft drive, it requires a lot of maintenance lubrication as well as a lot of cleaning as it attracts dirt most of the time. The power loss due to friction while using a chain drive is estimated to be around 3%

Belt

Belt drive technology is mostly seen in scooters and cruiser motorcycles. The chain drives and the belt

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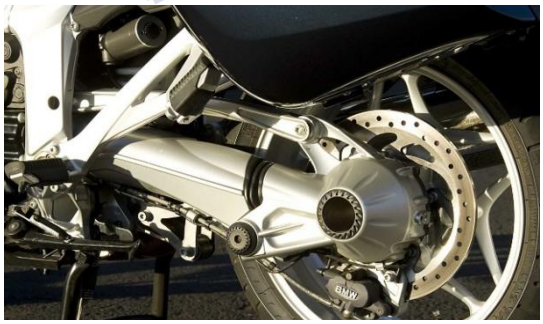
drives work under the same principle with the only difference being that it uses a kevlar belt to transmit motion rather than a chain for a smoother riding experience. When it comes to lubrication, the belt drives don't need any of it and thus completely out matching the chain drives on that aspect. Though they aren't maintenance free as in the case of shaft drives, but the belt drives have a longer life span when compared with the chain drives and it requires little to no maintenance. But on the contrary it carries serious concerns over its concerns usage making it less desirable. The power loss due to friction while using a belt drive is estimated to be around11%

Shaft Drive:

A shaft drive mechanism is completely difference when compared with the other types of transmission mechanisms. Unlike chain and belt drives, they could be used on both the two wheelers as well as the four wheelers. It produces hardly any noise and requires the least maintenance and provides the smoothest driving experience and has the longest life span when compared with the other two types. The major drawbacks associated with the shaft drives includes its expensiveness and its heavy weight. Its limits any customisations and in order to make certain modifications, the entire design has to be reworked which again increases the cost. Furthermore, it is the least efficient which when used incurs a loss of power due to friction which is estimated to be around 33%.



Looking at the components used in a commercial EVs, the batteries and the motor form the integral composition of the vehicle. Looking at the motor we find the demerits upsetting, which includes but not shortlisted to, the expense, liableness

As mentioned above there is a notable amount of loss of power while using a traditional transmission system. Hence, we realise the need for direct drive mechanisms which when put into use could reduce the total power loss to as lower as 1%.

Solution:

In any vehicle be it Electrical or IC Engine powered the transmission process as all but same and the only difference being IC Engine and the motor. Present, in IC vehicles and EV's contain transmission unit. As the movement of the vehicle is dependent on it, the vehicle which ultimately result in various losses with friction being the primary concern. In order to overcome the drawback, we have framed our design accordingly.

We have eliminated the traditional motor and the transmission and used a magnetic strip covering permanent magnets along the frame of the alloy wheel rim. We have fixed a coil head which goes around the frame and is given a clearance of certain degree of opening asshown below for opening.

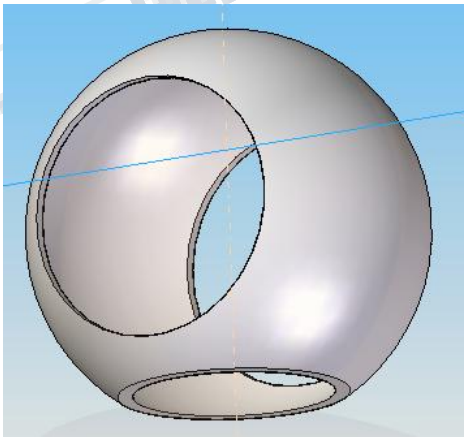


Fig:4 Total Casing

To avoid the presence of the coil the point of contact of the tyre and road. This coil is connected to the supply and when it is changed, it acts as a permanent magnet. The motion of the vehicle is achieved by the permanent magnets fixed along the wheels.

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CONCLUSION:

The direct drive mechanism is not only eco-friendly as it could be used only on EVs, it can also reduce the power loss due to friction found in transmission system in the current commercial vehicle.