Review on Electric Vehicle Transmission System

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Abstract: In a world where environment safety and energy conservation are concerns, the development of electric (EV) has considered faster. The need of having commercially feasible electric vehicles is becoming a reality. This paper reviews the present status of electric universal and their various factors, with importance on the engineering viewpoint and key technologies. The importance of the incorporation of technologies of automobile power generation, batteries and its performance, energy storage and controls, comparison of Electric, Hybrid, and Internal combustion engine and finally the challenge of EV charging Station are discussed. Consumer demands for CO reduction, efficiency, and performance, automakers are accelerating the introduction of electrified and hybrid vehicle propulsion systems. Electric motor is its torque characteristic which provides maximum torque from zero up to low speeds, and then it is governed by the maximum power available as motor speed increase. A four-speed transmission for electric vehicles is developed using environmentally-friendly fuel.

Keywords **- Electric Vehicle (EV), CO reduction, Electric motor, transmission, environmentally friendly.**

I. INTRODUCTION

Today Automobile industries over the globe are all set to file the EVs to make a pollution free globe Nowadays, due to the use of internal combustion engines, the effects on the environment are increasing day by day. To avoid this effect of pollution and to build a cleaner environment, the society of automobile industry is trying to find a new way by introducing electric vehicles because in the past as we have experienced hybrid electric vehicles, were causing less pollution but that was not enough to stop the complete rate pollution.

- **What is EV (Electric Vehicle)?**

An Electric Vehicle has a better technology and a more immeasurable efficiency as compared to the Internal Combustion engine. This research article focuses on the complete structure of the Electric Vehicle and the elements used in the Electric Vehicles. This also refers to the power generated and the performance of the battery according to the market situations. The chief issue is the battery performance which we have highlighted here in the paper. The significance of the charging stations and the region to embellish the new station. The fuel stations are the foremost source where we can put on the charging services every five kilometres. This would prime to secure the time and also a rush free environment around the charging station. The drive train system of pure electric vehicle has several structures, for
Example,

1. Traditional multiple-speed transmission with clutch;
2. Single-speed transmission without a clutch;
3. Two independent motors and fixed gear transmission with drive shaft;
4. In-wheel motor;
5. Continuously Variable Transmissions (CVT);
6. Double Clutch Transmissions (DCT)

In order to improve the shift performance of AMT, a lot of control, methods have been put forward, no-linear estimation and so on. The control of AMT always focuses on the cooperation control of clutch, synchronizer and internal combustion engine or traction motor. The gear shifting control of AMT is expected to meet the following:

1. Requirements at the same time.
2. Minimizing clutch lockup time;
3. Minimizing friction losses;
4. Minimizing the jerk during the shifting process;
5. Ensuring the smooth running of a vehicle.

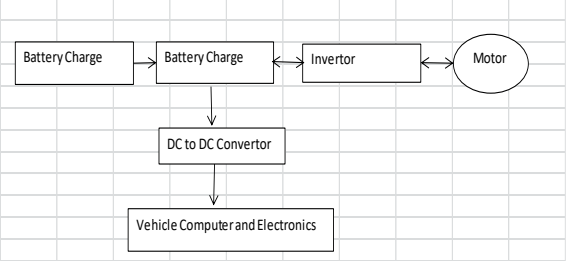

Fig.No1. The Layout of Electric vehicle.

Working of an e-vehicle Principle:

The electric motor gets its power from a controller which in turn gathers power from a rechargeable battery. The electric vehicle operates on an electric/current principle. It uses a battery pack to provide power for the electric motor. The motor then uses the power (voltage) received from the battery pack to rotate the transmission system, thereby, turns the wheels. A potentiometer is hooked to the accelerator pedal which signals the controller how much power is to be delivered.

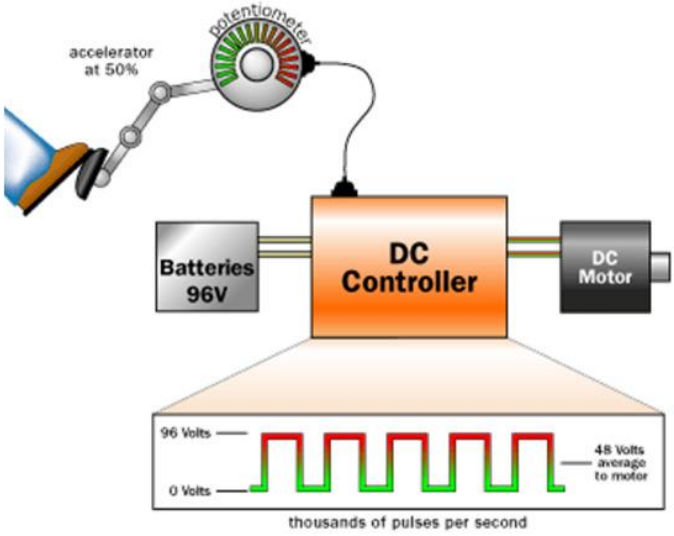

Fig No 2:. Working of EV

Major components of EV.

1. **Motor controller**

The motor controller of an electric car manages its complete process and the distribution of its power at any given moment. It acts as a head gate between the motor and batteries. It helps monitor and regulates all key performance signals such as the vehicle's operator, motor, battery, and accelerator pedal. It has a microprocessor which can limit or forward current. It is used to either improve the performance of the car or suit the operator's driving style. There are also more refined controllers which are capable of greater accuracy and thus, higher efficiency

2. **DC Motor.**

Electric engines can be structured to use either AC or DC current. AC motors tend to be less expensive and lighter than DC engines, reaching about 95% efficiency at full load compared to the 85%-95% attained by AC engines. AC engines are more common in other types of electrical devices and, due in large part to the reduced number of moving parts; tend to be suffering from less mechanical wear and tear. AC technology requires a more sophisticated controller, however.

3. **Transmission System.**

- Torque convertor
- Gear Box.
- Differential.

The function of the drive system is to transmit mechanical energy to the traction wheels, generating motion. An electric car does not require a conventional transmission. However, it has different internal arrangements depending on the components in use. For example, there are some designs which use multiple smaller motors that power each wheel individually. Bulky electric motors, on the other hand, may be coupled to the rear wheels using a differential housing.

4. **Battery**

- Lithium-Ion Batteries.
- Lead Acid Batteries
- Nickel Metal Hydride Batteries

Lithium-Ion Batteries: This battery technology gives good performance and range. However, it also carries the highest price tag. Lithium-ion batteries are lighter than Lead acid and Nickel metal.

Lead Acid Batteries: This battery technology is the most popular. It has a cheaper cost. It has a 97% recyclable ability.

Nickel Metal Hydride Batteries: This battery technology gives higher output and better performance but it costs much more than lead-acid batteries.

II. LITERATURE REVIEW

1.“ Design and Study of Transmission System for Electric Vehicles” paper is published by Ashwin Chander

This paper proposes a design for a multi-speed transmission for electric vehicles (EVs).In the present scenario, current electric vehicle manufacturers have deviated from the inclusion of multi-speed transmission systems from their vehicles, keeping in mind the additional bulk, complexity and cost that it adds. But considering the characteristics of an electric motor various modifications (making the system clutch-less and limiting the gear selection to 3-speed) can be made to make the conventional transmission systems suitable for electric vehicles, as multi-speed transmission systems do promise to provide reduced energy consumption and increased efficiency for EVs, hence increasing the “range” of the EV. Also, the benefits of downsizing of the motor and battery components can be gained.

2. "Design and Development of Power Transmission System for Greenand Light Weight Vehicles: *A Review*" paper is published by Hailemariam N. Hailu

A study on green vehicle was introduced and promoted to minimize the problem of air pollution caused by emissions of conventional vehicle. Green mobility are vehicles with low fuel/energy consumption and low/zero exhaust gas emission, these vehicles are like hybrid, battery powered, and fuel cell electric vehicle that can be enhanced to be more efficient than the conventional vehicles through a new design and development of power transmission system. Power transmission system for green and lightweight vehicles consists of different components like gear box, propeller shaft, differential and final drive. In this review more emphasis is given to gear box due to some reasons: firstly, it is one of the heaviest component of the power train system and as a result weight reduction is critically needed to increase the efficiency of the vehicle. Secondly, gearshift takes place therefore, torque interruption needs to minimize. The use of simulation software's i. e. Mat lab, AME vb sim, cruise software and other similar programs can simulate high-efficiency power transmission system. The results from the simulation software will be validated by experimental tests on test rigs. One way of minimizing fuel consumption is to reduce the weight of the gearbox by 10% reduction in vehicle weight can improved fuel economy by about 5-7%. As different researchers confirm that to have high vehicle efficiency the type of the transmission they used matters. A vehicle using automated manual transmission (AMT) and dual clutch transmission is more efficient in terms of less energy loss and gearshift comfort.

3. "Recent Development on Electric Vehicles" 2009 3rd International Conference on Power Electronics Systems and Applications." Paper is published K.W.E CHENG

This paper provides an overview of the recent work of electric vehicle in the region. The paper describes the development and the comparison of different part of components. The major components in battery technology, charger design, motor, steering and braking are examined. The paper finally shows some electric vehicle prototype as a conclusion of the papers.

4. "Three-Speed Transmission System For Purely Electric Vehicles" paper is published by Z. ZHANG;

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5. "An overview of electric vehicle concept and power management strategies" paper is published by Dr. Chokri Mahmoudi;

Power management in electric Vehicle has been revolutionized since the old power structure introduced with first EVs. Today, it can be powered either by a single or a combination of multiple sources and driven by a single or a combination of multiple algorithms. This enhancement contributes in significantly better results. This paper reviews state-of-art on electric vehicle concept giving description for each sub-category, and then details power management strategies and charging techniques highlighting main problems and solutions. Finally, power management structure and future research direction are also discussed.

III. Problem Statement

Its predict the energy consumption with a variable and fixed ratio gearbox over a standard driving cycle in order to understand whether this could offer significant efficiency gains. That is possible to improve overall energy consumption levels by around 5 to 12% with a variable ratio gearbox depending on the driving cycle used. However, there are many other practical considerations which must be weighed against this positive result and the paper discusses the - impact of several of these such as, gearbox efficiency, additional weight, cost and complexity, effect on drivability and potential for motor downsizing.

IV. EV Transmission System

When a 3 phase input is given to stator it creates a rotating magnetic field and hence induces a current in rotor and it starts rotating. The speed of induction motor depends on the frequency of AC supply, by changing the frequency of power supply; the speed of drive can be changed.

The IC engine requires speed varying transmission whereas electric vehicles can work on any speed, it does not require a speed varying transmission. The power generated in the electric vehicle motor is transferred to a drive wheel via a gearbox. The EV uses single-speed transmission because the motor is efficient in a wide range of conditions. The EVs have only one driving gear (a step-down transmission) because an electric induction motor is efficient from 0 RPM up to around 6,000 RPM. The opposite of ICEs, induction motors generate the vast majority of their torque, which is needed for acceleration, at 0 RPM, and are most efficient at power generation at high RPM, which is needed for cruising. In a frictionless world, it would be helpful – but still not necessary – for an EV to have multiple gears, as fuller advantage could be taken of the motor's peak efficiency. But for the foreseeable future, adding gears would only complicate a simple, reliable system.

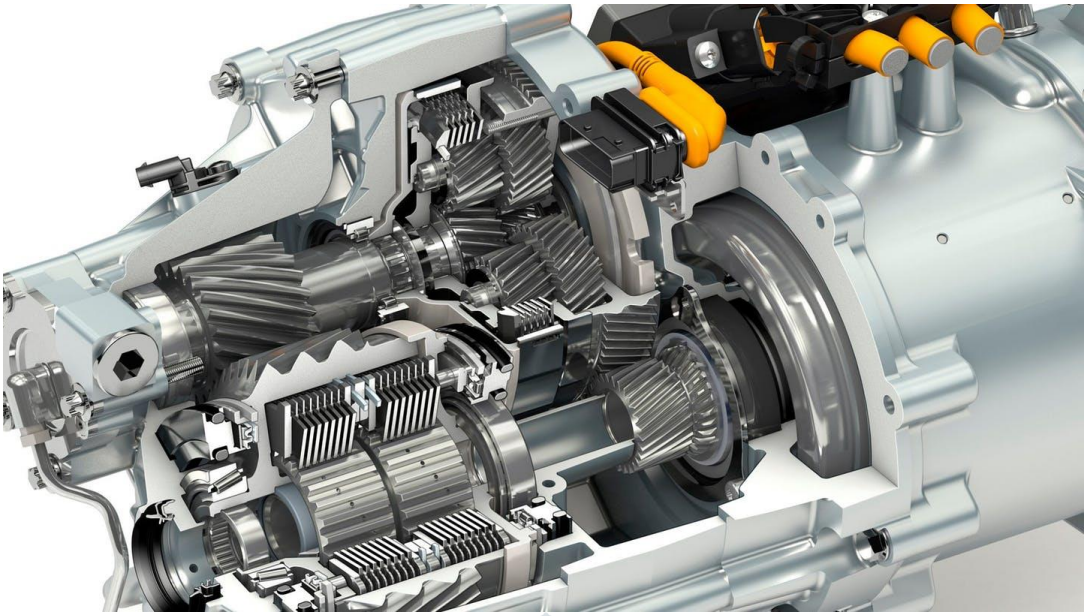

Fig No 3: Cut section of 2-speed transmission.

EV Power Systems (Motors and controllers)

The power system of an electric vehicle consists of just two components: the motor that provides the power and the controller that controls the application of this power. In comparison, the power system of gasoline-powered vehicles consists of several components, such as the engine, carburettor, oil pump, water pump, cooling system, starter, exhaust system, etc.

Motors

Electric motors convert electrical energy into mechanical energy. Two types of electric motors are used in electric vehicles to provide power to the wheels: the direct current (DC) motor and the alternating current (AC) motor.

DC electric motors have three main components:

- A set of coils (field) that creates the magnetic forces which provide torque.
- A rotor or armature mounted on bearings that turns inside the field.
- Commutating device that reverses the magnetic forces and makes the armature turn, thereby providing horsepower.

As in the DC motor, an AC motor also has a set of coils (field) and a rotor or armature; however, since there is a continuous current reversal, a commutating device is not needed. Both types of electric motors are used in electric vehicles and have advantages and disadvantages, as shown here. While the AC motor is less expensive and lighter weight, the DC motor has a simpler controller, making the DC motor/controller combination less expensive. The main disadvantage of the AC motor is the cost of the electronics package needed to convert (invert) the battery‘s direct current to alternating current for the motor. Past generations of electric vehicles used the DC motor/controller system because they operate off the battery current without complex electronics. The DC motor/controller system is still used today on some electric vehicles to keep the cost down.

However, with the advent of better and less expensive electronics, a large number of today’s electric vehicles are using AC motor/controller systems because of their improved motor efficiency and lighter weight.

These AC motors resemble motors commonly used in home appliances and machine tools and are relatively inexpensive and robust. These motors are very reliable, and since they have only one moving part, the shaft, should last the life of the vehicle with little or no maintenance.

- **EV Gear Box.**

Electric car gear box is a unique gear box. They don’t have multi-speed gear box as an IC Engine. This gear box work on a single stick engine due to this the acceleration is very fast. According to the research the electric can take on the speed of 20,000rpm which is much higher than the usual speed of an IC Engine gear box which gives 4,000-6,000rpm..

Currently only single speed reducers and motor controllers are used in commercial EVs due to characteristics of electric motors being sufficiently suitable to meet basic driving demands. Addition of a multi-speed transmission system can be advantageous, but only if it is designed specifically for an electric vehicle. As conventional transmissions are designed for IC engines, they disengage the engine power while shifting gears using a clutch. The same is not needed for an electric motor. The transmission keeps the motor in its optimal operating range and matches it with the vehicle speed. This results in lower power consumption and hence higher vehicle range. But manual transmission system tends to be bulky and also consists of constant use of clutch while shifting gears. This leads to power loss and makes it less efficient to be used in electric vehicles. Similarly, conventional automatic transmission systems are not the solution because of the weight it will add to the overall system. The proposal is the use of three-speed constant mesh gear box. Also, in this kind of gear box the gears are always in a state of mesh and thus removing the possibility of slip between engaging gears. Thus, reducing the transmission losses to a certain extent. Additionally, the frictional clutch is removed, which would have been otherwise used to disengage the prime mover from the gearbox in order to shift gears. Instead, a motor controller can be used, which would regulate the speed of motor while shifting gears.[1]

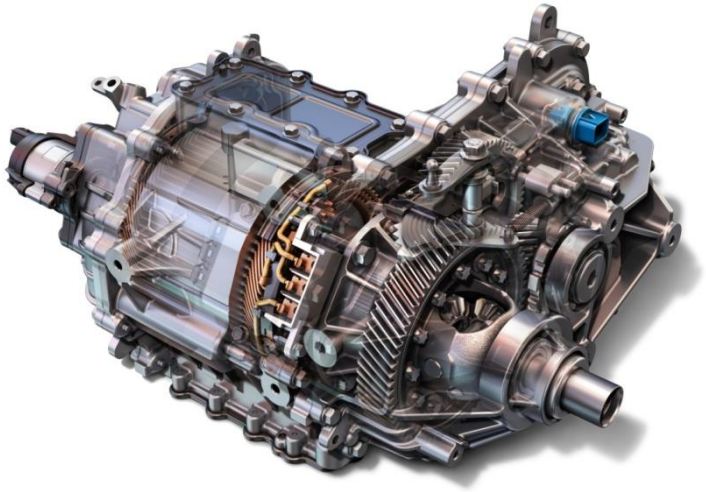

Fig No 4: 3-Speed Transmission

V. CONCLUSION.

This paper discusses the recent development in electric vehicle. The paper first describes general structure and discusses the energy storage component. It then extends to the future vehicle component. In the near future, combining diverse energy sources and powertrains in optimal way, as well as performing an accurate and robust power management control, will be essential to build a reliable and affordable EV while preserving our environment and intelligently using our limited resources.

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